The Welding Engineer

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A New Street In Our Town

Streets are avenues of communication. By means of them people are able to travel to their destination. In olden days folks depended upon cross-lot trails—the means of communication being both tortuous and uncertain.

The welding field, so far as the transmission of information was concerned, has been in something like the same position as the frontier settlement—dependent upon "cross-lot avenues" of communication.

Welding has come to be a most important branch of mechanics. By means of welding by one of the several processes whole industries have been revolutionized. The growth of the welding industry during the last few years should not be attributed to a wave of prosperity which has swept over this country, but rather to the fact that welding by some process is an efficiency and economic practice.

We may confidently expect the field to expand, and certainly a powerful aid in the enlightenment and expansion of any industry is a strong, fearless, well-constructed trade paper.

It requires time to build a really first-class paper, but we believe the broad-gauged enthusiasm which prevails in the welding industry has made it possible for us to present you with a good paper in jig time.

L. B. Mackenzie

Ethics of *THE WELDING ENGINEER*

1. To consider first the factor of safety. The Welding Engineer is unalterably opposed to the manufacture or sale of unsafe devices.
2. To consider and safeguard the interests of the subscriber.
3. To keep reading columns independent of advertising considerations and to measure all news by this standard: "Is it real news?"
4. To decline any advertisement which has a tendency to mislead or which does not conform to business integrity.
5. To solicit subscriptions and advertising solely upon the merits of the publication.
6. To supply advertisers with complete and reliable information regarding quality and character of circulation, including detailed circulation statements, subject to proper and authentic verification. The Welding Engineer, however, will not furnish or procure mailing lists for individuals or concerns for trade purposes.
7. To co-operate with all individuals and organizations in stimulating and extending the welding business.
8. To avoid unfair competition.
9. To determine what is the highest and largest function of the field and then to strive in every legitimate way to promote that function.

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The largest makers of Oxy-Acetylene Welding and Cutting Equipment and Supplies in the World

Oxweld Equipment includes Acetylene Generators, Welding and Cutting Blow Pipes, Regulators and Supplies—everything needed for all requirements—complete installations for the most extensive manufacturing and repair operations to portable units for emergency and field use. Because of the scientific accuracy and exactness of design—high quality materials and the mechanical perfection of construction and workmanship, **OXWELD EQUIPMENT** will produce the most efficient and economical results in welding and cutting operations of every character.

Oxweld Supplies are made up in accordance with the formulae of our metallurgists—tested by analysis in our laboratory and their merits tested out and proven by our expert welders in actual shop practice. We guarantee **OXWELD SUPPLIES,** when used by competent welders, to produce better results than any others known to the art today.

Our knowledge and experience, as the largest makers of welding and cutting equipment in the world, are always at the service of every purchaser and prospective purchaser of **OXWELD APPARATUS,** to determine the most economical and efficient applications of the **PROCESS** to the manufacturing or repair problems at hand.

Write us for information on any class of Welding or Cutting Work

Oxweld Acetylene Company

CHICAGO
36th St. and Jasper Place

NEWARK, N. J.
6460-680 Frelinghuysen Ave.

LOS ANGELES
654-656 Pacific Electric Bldg.

THE

BUCKEYE

OXY ACETYLENE

Welding and Cutting Outfits

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STATIONARY

or

PORTABLE

■ ■ ■

Ask for Catalog K

Live Firms Wanted

To Represent Us in Territory Not Allotted

■ ■ ■

Only Firms Who Will Demonstrate Desired

■ ■ ■

We Build Both Oxygen as Well as Acetylene Generators

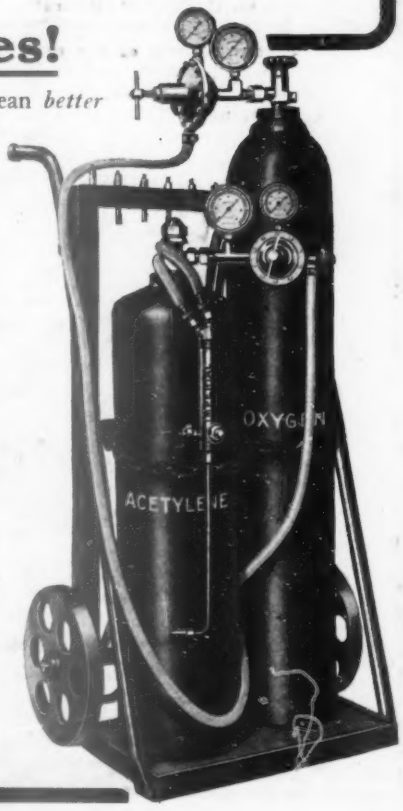
THE MACLEOD COMPANY, East Pearl Street, CINCINNATI, OHIO

Atlanta Agents, **THE BIRD-WILCOX CO., Atlanta, Ga.**

IMPERIAL WELDING AND CUTTING EQUIPMENT

OXY-ACETYLENE PROCESS

No. 1 Welding Outfit on Truck



Note These Big Features!

—features that no practical welder can overlook—features that mean *better work, great time saving and all-around economy*—are offered in Imperial Oxy-Acetylene Welding and Cutting Equipment.

Safety Back-firing is the most dangerous drawback to most welding and cutting apparatus. Numerous rigorous tests prove that Imperial Equipment absolutely overcomes this vitally serious detriment, thus permitting the operator to work in a cool, confident attitude, with increased production as a result. Imperial Regulators have an automatic safety feature possessed by no other regulators.

Efficiency The Imperial Welding Torch produces a perfectly-mixed, accurated-regulated, long, white, incandescent flame—entirely free from carbons and oxides. Makes a quick, uniform, permanent weld.

The multi-jet Imperial Cutting Tips produce a closely confined, accurately proportioned jet that makes a clean, narrow, rapid cut through the thickest steel or wrought iron.

Economy No other equipment compares with Imperial in economical operation. Cheap equipment is practically wasted money—it is a voracious consumer of gas—short lived—produces inferior work—is often dangerous to use Imperial torches produce the hottest flame—the best weld—at least consumption of gas.

Write for new catalogue, just off press, giving valuable operating data.

Imperial Brass Mfg. Co.

522 So. Racine Ave. CHICAGO

I.O.C. SYSTEM Bipolar Oxygen and Hydrogen Generator

(Patented)

Type L

Capacity, 3600 cu. ft. Oxygen and 7200 cu. ft. Hydrogen per 24 hours. Length 15 ft.; width 5 ft.; height 8 ft.; Plates 36 in. square. Current required—320 amperes by 120 volts D.C. Purity of the OXYGEN direct from generator 99.6%, and of the HYDROGEN 99.8% or better.

Showing plate with asbestos diaphragm that keeps gases apart but allows the electrolyte to circulate.

This I. O. C. Bipolar Oxygen and Hydrogen Generator is equal in productive capacity to 50 unit cells and requires only one-sixth the floor space.

The advantages of the I. O. C. Bipolar Oxygen and Hydrogen Generator will be apparent to all users of Oxygen and Hydrogen, *and especially to those who desire to secure the material economies effected by producing these gases in their own works.*

The **I. O. C. Bipolar Generator** is the first thoroughly efficient machine of its type and is the result of years of study and experimentation.

The compactness of the machine, its high efficiency, the high purity of the gases produced, the excellent mechanical design and the use of patented devices which insure safety and continuity of operation, together with the high grade of materials used in the construction of the machine, giving it great permanency and ruggedness, make this type of I. O. C. Generator very desirable to all users of **Oxygen** and **Hydrogen.**

Its adoption means the utilization of small space, elimination of cylinder storage and waste connected therewith, an ever ready source of supply of *Oxygen* and *Hydrogen* of the highest efficiency, at low operating cost, and at a negligible maintenance cost.

The I. O. C. Bipolar Oxygen and Hydrogen Generator will save its cost within a year. Made in several sizes.

Type F

Capacity, 900 cu. ft. Oxygen and 1800 cu. ft. Hydrogen per 24 hours. Length, 11 ft.; width 4 ft.; height, 5 ft.; Plates, 18 in. square. Current required—80 amperes by 120 volts D.C.

International Oxygen Company

General Sales Office: 115 Broadway, N. Y.

Works: Newark, N. J.

Branch Office and Works: Verona, Pa.

Our new Booklet, "I. O. C. Bipolar Oxygen and Hydrogen Generator" describes in detail its application and operating principle.

May we send you a Copy?

This Generator is being installed by the Navy Department at Navy Yard, Pensacola, Fla., and by several large manufacturing companies, whose names we shall be pleased to furnish on request

WELDING

There is more Davis-Bournonville Apparatus in general use for oxy-acetylene welding and cutting than of any other.

It has been in general, practical use for welding and cutting longer than any other in this country.

It is being used by metal workers for a greater variety of operations in manufacturing metal goods.

The largest foundries and steel mills in the country are using it for reclaiming defective castings, welding, steel cutting.

The largest locomotive and car-building shops are using it for welding and cutting on construction and repair work.

The Medal of Honor (higher award than the Gold Medal), the Highest Award for Oxy-Acetylene Apparatus at the Panama-Pacific Exposition, was awarded Davis Apparatus.

CUTTING

The largest ship-building and dry docks and all United States Navy Yards are using it for steel cutting and repairs.

The largest range boiler and steel tank manufacturers are welding their product with it.

The largest steel furniture, door, sash and frame makers employ it in manufacturing.

The largest automobile metal-body builders are using it extensively for welding.

The largest scrap yards are using it for cutting and wrecking.

Hundreds of small repair shops and garages are daily making profitable use of small outfits.

Concerns that have made oxy-acetylene welding and cutting the big success it is, installed "D-B" apparatus because they gave efficiency of the apparatus and the value to be obtained from it first consideration in selecting equipment—because it provides the widest range of equipment made for obtaining the full value of the oxy-acetylene process—because the long practical experience of the "D-B" Company in its own welding shops and development and demonstration departments made it possible for the company to be of practical service to its customers.

These are reasons that will have weight with the prospective purchaser of welding and cutting equipment, whether his requirements are small or great.

Full information, catalogs, bulletins and co-operative service in determining the customer's application of the process will be given on request.

Davis-Bournonville Company

NEW YORK CHICAGO

Address General Offices and Demonstration Plant, JERSEY CITY, N. J.

Sales Offices: New York, Chicago, Detroit, Cleveland, Pittsburgh, Philadelphia

General Dealers in New England, Southern and Western States

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ACETYLENE (Compressed in Cylinders)
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The Prest-O-Lite Co., Inc.
The Searchlight Co.
Universal Oxygen Co.

ACETYLENE GENERATORS
Bermo Welding Apparatus Co.
Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
International Oxygen Co.
The Macleod Co.
Oxweld Acetylene Co.
Vulcan Process Co., Inc.

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Oxweld Acetylene Co.
The Searchlight Co.
Universal Oxygen Co.
Vulcan Press Co.

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Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
The Searchlight Co.
Universal Oxygen Co.
Vulcan Process Co.

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Universal Oxygen Co.

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ASBESTOS SHEET PAPER
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Universal Oxygen Co.
Vulcan Process Co.

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The Welding Engineer

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Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
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The Searchlight Co.
Universal Oxygen Co.
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Henderson-Willis Welding & Cutting Co.
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Universal Oxygen Co.
Vulcan Process Co.

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Toledo Electric Welder Co.

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Union Carbide Co.

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The Linde Air Products Co.
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Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
The Macleod Co.
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The Prest-O-Lite Co., Inc.
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Universal Oxygen Co.
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The Searchlight Co.
Universal Oxygen Co.
Vulcan Process Co.

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Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
The Searchlight Co.
Universal Oxygen Co.
Vulcan Process Co.

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The Linde Air Products Co.
Universal Oxygen Co.

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ELECTRIC RESISTANCE WELDING MACHINES
(See Spot, Butt and Seam Welders)
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Toledo Electric Welder Co.
Westinghouse Electric & Mfg. Co.

ELECTROLYTIC OXYGEN PLANTS
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Universal Oxygen Co.

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Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
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The Searchlight Co.
Universal Oxygen Co.
Vulcan Process Co.

FILLER RODS (Bronze)
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Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
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The Searchlight Co.
Universal Oxygen Co.
Vulcan Process Co.

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Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
The Searchlight Co.
Universal Oxygen Co.
Vulcan Process Co.

FILLER RODS (Manganese Bronze)
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Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
The Searchlight Co.
Universal Oxygen Co.
Vulcan Process Co.

FILLER RODS (Swedish Iron)
Bermo Welding Apparatus Co.
Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
The Searchlight Co.
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Vulcan Process Co.

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Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
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The Searchlight Co.
Universal Oxygen Co.
Vulcan Process Co.

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Oxweld Acetylene Co.
The Searchlight Co.
Universal Oxygen Co.
Vulcan Process Co.

FIREPROOF PLASTIC

FIREPROOF PLASTIC BINDER

FLUE WELDERS (Electric Resistance)
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Westinghouse Electric & Mfg. Co.

FURNACES (Annealing)
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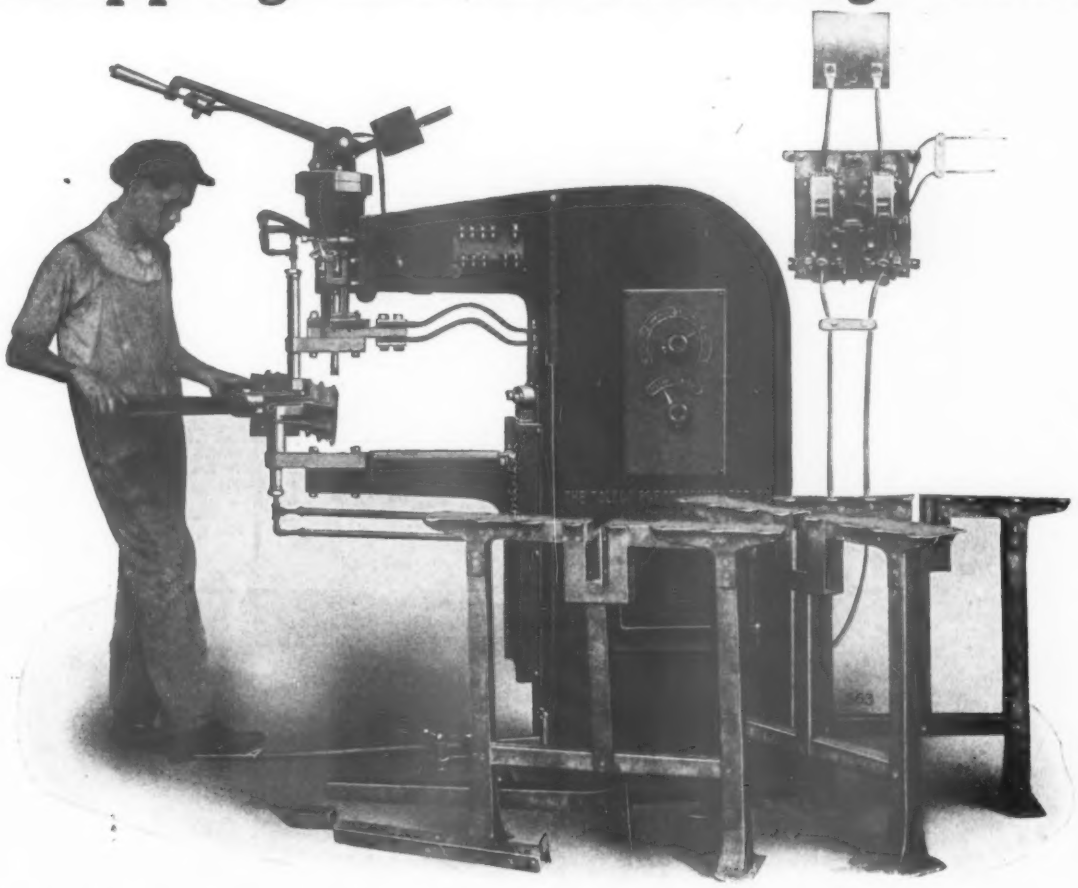
Universal Oxygen Co.

FLUX (Aluminum)
Bermo Welding Apparatus Co.
Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
The Searchlight Co.
Universal Oxygen Co.
Vulcan Process Co.

Chopping Down Riveting Costs



One of the many TOLEDO welding machines that has paid for itself in actual savings in a few weeks' time

A boy will spot weld 6 to 8 pieces in the same time required to rivet **one.** 5 to 7 less boys at $1.75 to $2.00 per day equals $10.00 to $14.00—this saving to apply on a "TOLEDO" welder.

Send in your samples to be welded free and returned to you; test them, and then find out how much you can save by electric welding them with a Rivetless Riveter. Order your machine shipped on 30 days' trial—if you don't want it after trying it out—**ship it back.**

HIGH SPEED STEEL THROWN AWAY

$3.00 per pound is paid for high speed tool steel and the small pieces thrown away, when it can be saved down to the last stub end by electric welding it to low carbon steel.

This process can be used to make **planer tools, lathe tools, shaper tools.** We give full instructions for successfully doing this work with "TOLEDO" welding machines. We will tell you more about it if you give us a chance.

NO LEASE NO LICENSE NO ROYALTY

THE TOLEDO ELECTRIC WELDER CO.

Cumminsville - CINCINNATI, OHIO

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The Searchlight Co.
Universal Oxygen Co.
Vulcan Process Co.

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The Searchlight Co.
Universal Oxygen Co.
Vulcan Process Co.

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GASOLINE PREHEATING FURNACES

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Westinghouse Electric & Mfg. Co.

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The Searchlight Co.
Universal Oxygen Co.
Vulcan Process Co.
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The Searchlight Co.
Universal Oxygen Co.
Vulcan Process Co.

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Universal Oxygen Co.
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The Linde Air Products Co.
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International Oxygen Co.
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Vulcan Process Co.

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The Prest-O-Lite Co., Inc.
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Universal Oxygen Co.
Vulcan Process Co.

REGULATING VALVES (Hydrogen)

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Universal Oxygen Co.
Vulcan Process Co.

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Oxweld Acetylene Co.
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Universal Oxygen Co.
Vulcan Process Co.

THERMIT WELDING

Goldschmidt-Thermit Co.

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The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
The Searchlight Co.
Universal Oxygen Co.
Vulcan Process Co.

TORCHES (Gasoline and Kerosene Preheating)

The Macleod Co.
Oxweld Acetylene Co.
Westinghouse Electric & Mfg. Co.

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Davis-Bournonville Co.
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The Imperial Brass Mfg. Co.
The Macleod Co.
Oxweld Acetylene Co.
The Prest-O-Lite Co., Inc.
Universal Oxygen Co.
Vulcan Process Co.

TORCHES (Oxy-Acetylene Welding)

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Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
The Macleod Co.
Oxweld Acetylene Co.
The Prest-O-Lite Co., Inc.
The Searchlight Co.
Universal Oxygen Co.
Vulcan Process Co.

TORCHES (Oxy-Hydrogen Cutting)

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Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
Universal Oxygen Co.
Vulcan Process Co.

TORCHES (Oxy-Hydrogen Welding)

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Davis-Bournonville Co.
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The Imperial Brass Mfg. Co.
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Universal Oxygen Co.
Vulcan Process Co.

TRUCKS (Cylinder Carriers)

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Universal Oxygen Co.
Vulcan Process Co.

VALVES (Acetylene Regulating)

Bermo Welding Apparatus Co.
Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
International Oxygen Co.
Oxweld Acetylene Co.
The Prest-O-Lite Co., Inc.
The Searchlight Co.
Universal Oxygen Co.
Vulcan Process Co.

VALVES (For Acetylene Cylinders)

Commercial Acetylene Ry. Light & Signal Co.
The Prest-O-Lite Co., Inc.
The Searchlight Co.
Universal Oxygen Co.

VALVES (For Oxygen Cylinders)

International Oxygen Co.
Universal Oxygen Co.

VALVES (Hydrogen Regulating)

The Imperial Brass Mfg. Co.
International Oxygen Co.
Universal Oxygen Co.

VALVES (Oxygen Regulating)

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Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
International Oxygen Co.
Oxweld Acetylene Co.
The Searchlight Co.
Universal Oxygen Co.
Vulcan Process Co.

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Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
The Searchlight Co.
Universal Oxygen Co.
Vulcan Process Co.

WELDING (Electric Resistance-Custom Work)

Thomson Electric Welding Co.
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Westinghouse Electric & Mfg. Co.

WELDERS' GOGGLES

J. C. Adams
Bermo Welding Apparatus Co.
Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
The Searchlight Co.
Universal Oxygen Co.
Vulcan Process Co.

WELDING MACHINES (Electric)

See Arc, Butt, Seam Welders.

WELDING (Oxygen for)

International Oxygen Co.
The Linde Air Products Co.
Universal Oxygen Co.

WELDING TORCHES (Oxy-Acetylene)

Bermo Welding Apparatus Co.
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The Macleod Co.
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The Searchlight Co.
Universal Oxygen Co.
Vulcan Process Co.

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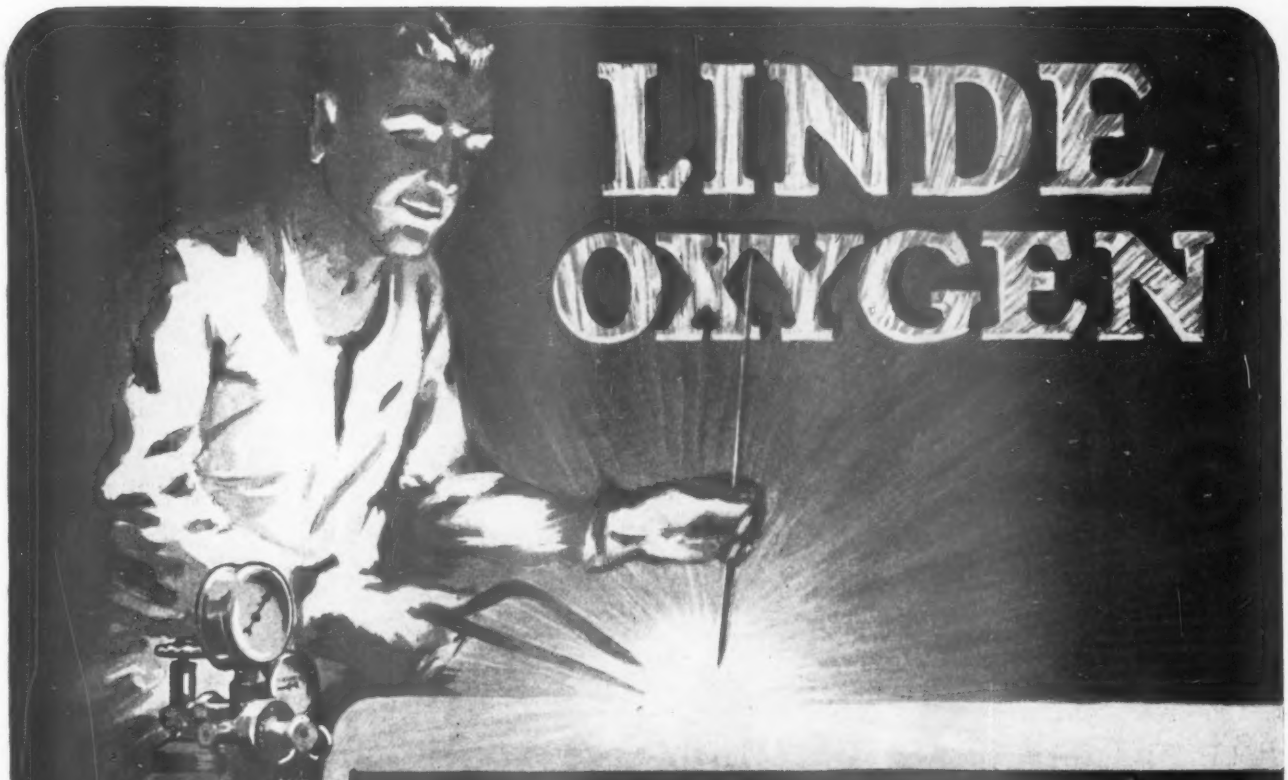
Bermo Welding Apparatus Co.
Davis-Bournonville Co.
Henderson-Willis Welding & Cutting Co.
The Imperial Brass Mfg. Co.
Oxweld Acetylene Co.
Universal Oxygen Co.
Vulcan Process Co.



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Because of its **uniform quality**—its **freedom from dangerous impurities**—its **unequalled nation-wide system of distribution.**

THIS DISTRIBUTION IS MADE FROM 37 STATIONS located in the heart of oxygen-consuming districts. At each of these stations we keep a large supply of Filled Cylinders ready at all times to meet ordinary and emergency demands.

THIS CONSTANT SUPPLY OF LINDE OXYGEN IS INSURED BY OUR 14 PRODUCING PLANTS AND OUR UNLIMITED STOCK OF CYLINDERS. The temporary shut-down of one of our plants would not affect the distribution of Linde Oxygen.

THIS DISTRIBUTION IS PART OF THE LINDE SERVICE WHICH HAS BROUGHT US THOUSANDS OF CUSTOMERS. We alone can offer such service.

ASK US WHAT THE USE OF LINDE OXYGEN WILL MEAN IN YOUR PARTICULAR CASE. WE will submit FACTS—not claims, and let you judge the advantages to be gained in using LINDE OXYGEN.

Write us today while you think of it.

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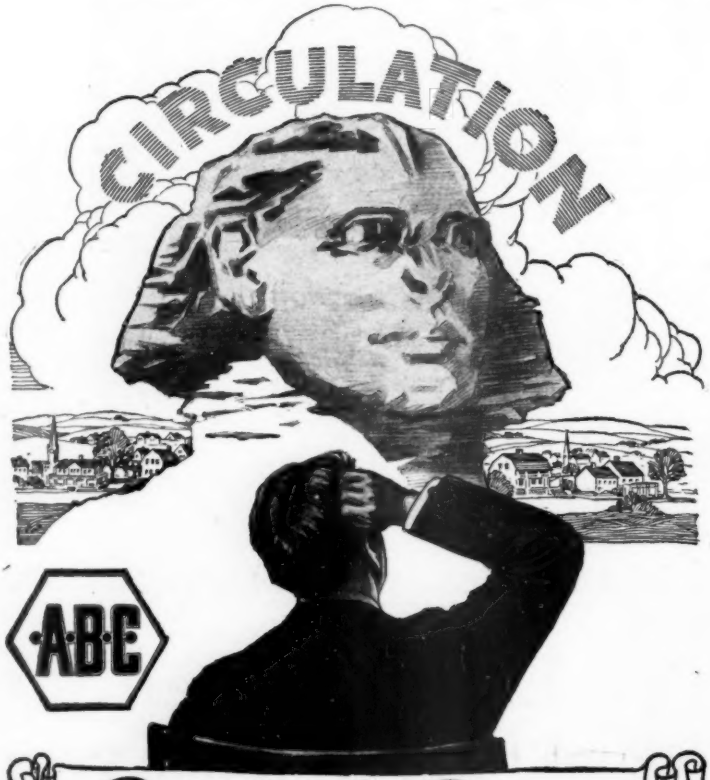
"Largest Producers of Oxygen in the World"

42nd St. Bldg. **New York City**



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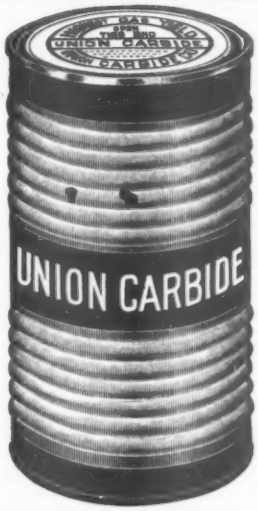

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Chicago, Ill., Peoples Gas Building — **New York City, 42nd St. Building**

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UNION CARBIDE

"World's Best Quality—Highest Gas Yield"

FOR OXY-ACETYLENE WELDING PLANTS AND CONTRACTORS' TORCHES, HOUSE LIGHTING GENERATORS, "Union Carbide" is always packed in 100-lb. blue and gray drums marked conspicuously, "UNION CARBIDE."

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FOR MINERS' LAMPS, specially selected "Union Carbide" packed in 100-lb. and 25-lb. blue and gray drums, marked conspicuously, "Miners' Lamp."

FOR MINERS' LAMPS, packed in cases containing six 10-lb. blue and gray cans; also in cases containing twenty-four 2-lb. blue and gray cans.

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FOR LARGE AUTOMOBILE LAMPS, "One inch" packed in cases containing six 10-lb. blue and gray cans.

FOR SMALL AUTOMOBILE AND BICYCLE LAMPS, "Half inch" packed in cases containing six 10-lb. blue and gray cans; also in cases containing twenty-four 2-lb. blue and gray cans.

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Sacramento—1523-31 Front St.
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San Francisco—Kohl Building.

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Hartford—877 Main St.

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MARYLAND
Baltimore—19 E. Lombard St.
Cumberland—1 N. Liberty St.
Salisbury—Opp. Fulton Station.

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Huntington—820 3d Avenue.

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Seattle—411 Globe Bldg., First Ave. and Madison St.
Spokane—646 Peyton Building.

WISCONSIN
La Crosse—Front and King Streets.
Madison—309 East Wilson St.
Milwaukee—120-134 Jefferson St.

We recommend our customers to **select** from the list, the **city** from which the quickest delivery and lowest **freight rate** can be obtained, **and address their orders to "Union Carbide Sales Company"** at the distributing point selected **accompanied by remittance.**
Please address request for information or special correspondence to either the Chicago or New York office.

Good Carbide

PROF. GEORGE GILBERT POND, of the Department of Chemistry, University of Pennsylvania, distinguished authority on Calcium Carbide, says:

¶ *"Present practice does, and future practice must, insist on purity of material. Good metallurgical coke, the analysis of whose ash shows only the merest trace of sulphur and phosphorus, is easily obtainable. This, with a reasonably pure lime, yields carbide of great purity, and there should be no other made."*

¶ This is the Ideal and the Endeavor in the manufacture of CARBOLITE, and is worthy both for ethical and economic reasons.

¶ Ethical because the consumer cannot tell, from appearance, the good from the poor; because he has no means of measuring the value as revealed in the gas yield. He *must* trust the maker.

¶ Economic because it costs as much, almost, to manufacture the poor as the good; the only saving, the imperfect fusion. Crushing, screening, and packing costs are the same. The details of ordering and selling are the same.

¶ Divergence begins with results. The same charge in the consumer's generator gives less gas, less satisfaction, there is more bother, more recharging, more removals of residue. And the imperfect fusion manifests itself in impure acetylene.

¶ This

TRADE Carbolite MARK

distinguishes *superior* from *inferior,* pure from impure, carbide, and stands for a definite, guaranteed gas yield.

American Carbolite Sales Company

Distributors

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Universal

UNIVERSAL OXYGEN COMPANY
SHEBOYGAN, WISCONSIN, U.S.A.

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WESTERN UNION AND POSTAL CODES USED.

Manufacturers of
PURE OXYGEN and HYDROGEN GASES
WELDING and CUTTING EQUIPMENT
Milwaukee Branch: 315 Fourth Street

The Searchlight Welder
and
What a User of Seven Other Devices Thinks of It

The following letter recently was received by the Searchlight Company from Mr. M. F. Schworm, one of its customers at Massillon, Ohio. The letter was entirely unsolicited.

The Searchlight Company, Chicago.

Gentlemen: I wish to express briefly my opinion of the Searchlight welding and cutting apparatus, in view of the fact that in the past seven years I have had seven different makes of outfits, always buying that which, in my mind, appeared to be best, regardless of price, until about six months ago I decided to purchase Searchlight equipment and now my only regret is that I didn't have it six years ago. Not once have I finished a job with the Searchlight outfit without a smile from ear to ear. Words can never express my appreciation of the Searchlight equipment. Of course, I realize that the best results can be obtained only when used in connection with Searchlight gas.

The significance of this letter for you rests not only in the fact that it is the testimonial of a welder of seven years' experience, but in the fact that it was wholly unsolicited.

Mr. Schworm gave it because he was enthusiastic and he was enthusiastic because he was pleased with the satisfactory work he was able to accomplish with the Searchlight equipment. And you will be just as enthusiastic and just as pleased and satisfied as Mr. Schworm when you own a Searchlight Welder and use Searchlight acetylene.

Our slogan is: "Better merchandise for less money and more merchandise for the same money"

and we justify this slogan by selling you a welding outfit equal in efficiency to the highest priced device on the market for the sum of $50 (which, of course, does not include oxygen or acetylene cylinders). The efficiency of the Searchlight Welder is guaranteed by us and is equal to any $100 outfit.

Searchlight acetylene is more efficient because it is dry acetylene. Write for "The Searchlight on Welding" and also our folder on "Dry Acetylene," and let us send you the details of our trial proposition.

Searchlight Company
1040 Karpen Bldg., Chicago

Branches and refilling stations at the following points:

Atlanta, Ga.	Buffalo, N. Y.	Chicago, Ill.	Dallas, Tex.	Kansas City, Mo.	San Antonio, Tex.
Boston, Mass.	Camden, N. J.	Cleveland, O.	Detroit, Mich.	Minneapolis, Minn.	Warren, Ohio

Welding Plants for All Purposes

12 Sizes—Ranging in price from $25.00 to $250.00

Write for catalogue and our special 30 day offer.

A "BERMO" Plant means more profit for you.

Shipment made same day order received. Liberal terms on plants if desired.

Address DEPT. C

Bermo Welding Apparatus Co., Omaha, Neb., U. S. A.

WILLIS OXY-ACETYLENE APPARATUS WELDERS

"WILLIS" PRESSURE GENERATORS

"Willis" Pressure Generators are made in sizes of 50 pounds, 100 pounds, 200 pounds and 300 pounds capacity of carbide per charge.

The generator of 50 pounds capacity is standard for repair shops and light manufacturers, while the larger sizes provide an ample supply of gas for more extensive use.

The "Willis" Pressure Generators stand alone. The theoretical engineer and the practical welder proclaim their superiority. One of the important features to be considered in an acetylene generator is

Safety. We have made **safety** the first consideration, and how well we have succeeded is attested by the fact that we have never had an accident or explosion occur to any of our apparatus—a record held only by this Company. Our apparatus is as near "fool-proof" as it is possible for mechanical appliances to be.

The "Willis" Generators have independent power for feeding lump carbide and automatically starts and stops according to the pressure of the gas. These generators require no attention after being filled with carbide.

THE WELDING TORCH

Of equal importance to the Acetylene Generator is the welding torch itself. The "Willis" torch knows no equal. It is of the medium pressure type, and is known as the Constant Neutral Torch. The mixture of the gases is obtained in the head, and interchangeable tips of different capacity are provided to regulate the size of the flame.

Heads having different angles are furnished and are also interchangeable. This is a special patented feature of our torch and is found to be of great assistance to the operator. For ordinary bench work a torch having a head at about a 90 degree angle is most desired, while for boiler welding such as side, flue, or crown sheet work, a much greater angle than 90 degrees is preferable. These heads of different angles all fit the same torch. Another advantage which the "Willis" torches possess is that the heads rotate on the torch proper and are easily and quickly turned to any angle in the arc. For overhead work and certain other classes, this is of great assistance. These features give the torch preeminence as to facility. We guarantee our torch to procure as low a ratio of oxygen to acetylene as it is possible to obtain and maintain a neutral flame.

THE CUTTING TORCH

The Welding Torch can be easily and quickly transformed into a Cutting Torch by simply removing the Welding head and replacing same with the cutting attachment. This attachment connects with the oxygen supply for welding and only one oxygen hose is required. With this cutting torch it is possible to cut in any direction, as the oxygen jet always impinges on hot metal.

MANUFACTURED BY

The Henderson-Willis Welding and Cutting Co.

GENERAL OFFICE AND FACTORY

ST. LOUIS, MO., U. S. A.

Welding Machinery

Electric butt, spot, ridge and point welding machinery for manufacturers of iron and steel products of all kinds

Oxy-Acetylene welding and cutting outfits for manufacturing and job repair work in all metals

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Which process is especially applicable to your business?

The engineering advice which we can furnish you with, free of charge, will cover thoroughly the requirements of the largest factory or the smallest job shop.

When installing machinery of any kind it is best to obtain all the data possible.

We only ask you to call on us for this information. It will be complete in every detail. All costs of investment, operation and overhead will be placed before you in concrete form, enabling you to choose the method most adaptable to your business.

Our welding-material supply department is complete in every detail. Write for prices, or better yet, send us your inquiries on your requirements as they arise.

WELDING MATERIALS, 720, 115 So. Dearborn Street, CHICAGO

WELDERS' GOGGLE No. 3

White non-rusting metal, folding screens, all metal parts covered to prevent the frame from getting heated and burning the skin. Fastened on by an elastic headband.

No. 3. Mounted with first quality flat, gray green Hallauer glass, per dozen.....$15.00
Extra glasses, ground to fit, per doz. 4.00

This goggle is a great improvement over similar goggles on the market, the screens and frame are all made in one piece making it easy to insert new glasses. The frame is of heavy construction and the temples are fastened to the end piece with screws.

The above goggles furnished with light smoked, blue, amber or clear white glasses

WILLIAM C. ADAMS

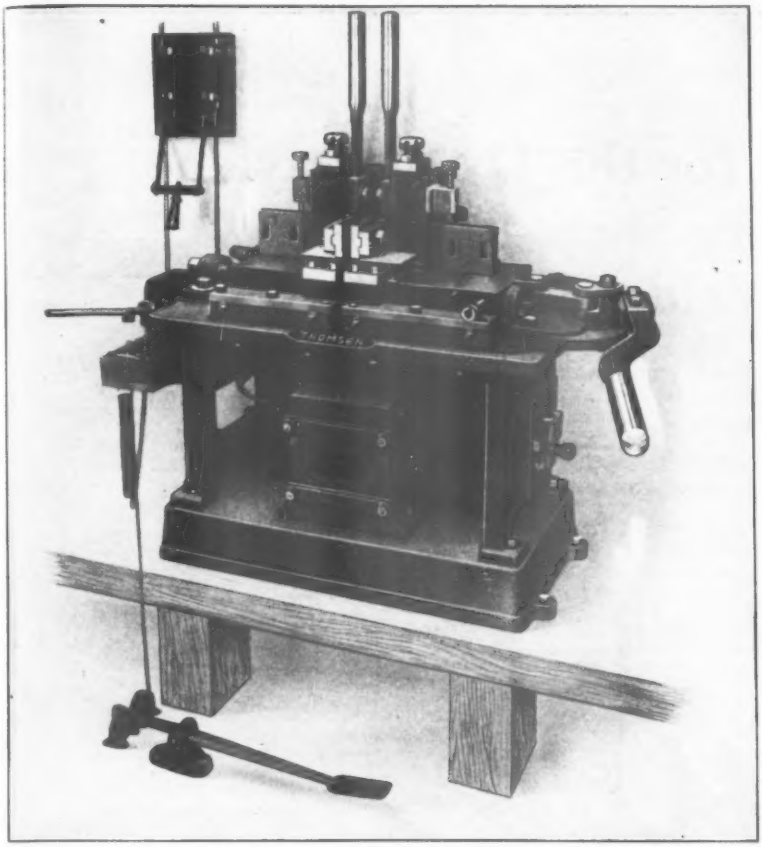
Manufacturer, Importer and Wholesale Dealer in

Welding Goggles and Protection Glasses

332 BOYLSTON STREET

BOSTON - - - MASS., U. S. A.

Write for Catalogue. Samples Submitted



Type 10-A Electric Welder. Capacity up to 7-8 inch round steel or equivalent section; also flat stock up to 3 inches wide. 15 KW, 15 seconds. 65 KW Hours. 1000 welds. 26x60x43 inches high. 925 pounds.

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Electric Welders

For low cost welding the Thomson "can't be beat." There are no long leads between transformer and work holders, and the work is clamped direct on the transformer terminals which means quick heating.

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There is a Place for the Oxy-Acetylene Process in Every Shop and Factory Where Welding is Done

NO matter what other welding process you use in your shop there is a vastly wider range of work that can be handled by the oxy-acetylene process of welding and cutting—in many cases, work that no other process can touch.

The oxy-acetylene process is full of wonderful opportunities for increased savings in all kinds of metal joining—whether repair work, construction work or metal manufacturing.

Increased savings are being made in many different lines of business. Old-fashioned wasteful methods have been eliminated by substituting oxy-acetylene welding for higher efficiency—without the necessity of investing in expensive, one-purpose equipment or any serious changes in established systems of production.

The simplest, most convenient and least expensive method of oxy-acetylene welding is the Prest-O-Lite Process. The entire equipment is portable—ready for use at all times at any point inside or outside the shop where welding is to be done.

Prest-O-Lite PROCESS

The Prest-O-Lite Process employes Prest-O-Lite Dissolved Acetylene (ready-made carbide gas) in convenient size cylinders, baked by Prest-O-Lite Service. Used as conveniently as cylinders of oxygen. Saves the large initial outlay and heavy depreciation of making crude acetylene in carbide generators. Prest-O-Lite Dissolved Acetylene is perfectly dried, cleaned and purified—makes better welds and is cheaper to use. Prest-O-Lite is used successfully with any good make of welding or cutting apparatus. If desired, we furnish thoroughly high-grade welding apparatus for $60.00 (Canada $75.00); ready-to-use acetylene supplied under a liberal service plan at additional cost. For metal cutting operations, Prest-O-Lite provides the most convenient fuel supply—the outfit may be taken to the work, giving portability to the outfit, which is essential on certain class of cutting work.

Write for this Illustrated Booklet on Welding

"Turning Waste Into Profit" is the title of a book we have prepared on the variety of welding and cutting operations that are being practiced by the Prest-O-Lite Oxy-Acetylene Process. A copy of this book will be gladly sent to you on request—also details of the Prest-O-Lite acetylene service plan. Write

The Prest-O-Lite Company, Inc.

The World's Largest Makers of Dissolved Acetylene

Main Office and Factory - - 836 Speedway, Indianapolis, Ind.

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The Welding Engineer

Published on the First Thursday of Each Month by

THE WELDING ENGINEER PUBLISHING CO.,
220 S. State St., Chicago, Ill.
Telephone Wabash 7134.

L. B. Mackenzie.....President & Editor

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Application made for entry at the postoffice at Chicago, Ill., as mail matter of the second class.

The Welding Engineer has made application for membership in the Audit Bureau of Circulations.

We guarantee that of this issue more than 4,000 copies were printed, excluding copies spoiled in press room and bindery. At the time of mailing the known distribution was (actual count always exceeds press order):

Copies to paid subscribers	1,072
Copies to advertisers	30
Copies to prospective advertisers	125
Copies to other trade papers, correspondents, etc.	20
Copies mailed as samples to prospective subscribers	2,643
Copies retained at office of publication to fill new subscription orders, etc.	100
Copies for office use	10
TOTAL	4,000

VOLUME I. JANUARY, 1916. NUMBER 1

The Welding Engineer

WELDING has come to be a most important branch of mechanics. The art of welding by one of the several processes now in use is not new, by any means, but it has been during the last three years that the progress made has been greatest. The last year, in fact, has witnessed vast strides and we confidently expect that the year 1916 will be the greatest in the history of the industry.

Big Business has profited by the War and many industries must attribute their prosperity, directly or indirectly, to conditions created by the situation abroad. This is not true of the welding industry, however, because welding by one of the several processes is an efficiency and economic measure, and in no sense of the word a proposition to be considered only during brisk times. Manufacturers who, three years ago, were forced to look about them for some means of reducing manufacturing and shop expenses and at the same time secure added efficiency have found that by employing some process of welding costs could be lowered, output increased and the quality of work improved. So that we may expect the welding industry to expand and thrive, no matter what conditions may arise at the close of the War.

In the past the problems of the welder have been treated by many of the leading trade journals of this country with beneficial results. The time has arrived, however, when the industry has reached a point where no one of the existing trade papers may devote sufficient space to welding topics to keep the interested reader fully advised on welding subjects. In other words, the welding industry has become a specialized field and a specialized trade paper is needed.

We feel that in presenting The Welding Engineer for your consideration we are taking a step that will be regarded with approval by every one in the trade. As a matter of fact, the principal manufacturers in the field have indorsed the movement and more than eleven hundred interested concerns have manifested their approval by subscribing to the paper in advance of the first issue. We hope to have the support of everybody connected with the welding industry and we give assurance that we will strive to merit it.

A Million a Day

A FEW years ago when an Eastern lawyer, Louis Brandies, said that the railroads of the United States were wasting one million dollars each day he was branded by railroad men as a fool. Today the railroads are saving millions of dollars each year by the aid of welding apparatus. We do not mean to infer that it is possible for the railroads to save as much as a million dollars per day through the aid of welding apparatus, but certainly a good start has been made in this department alone. We know of a Western road which in 1914 effected a saving of more than a quarter of a million dollars through the reclamation of broken and scrapped machines, parts and equipment. No figures are available as to what the saving due to increased efficiency in the shops amounted to, but it must have been large.

The next few years is bound to see a big increase in welding installations in American railroads, with a corresponding increase in efficiency and economy.

Our Welding Schools

IT is the popular belief that the Germans excel us in welding knowledge. In fact, in France, England and some other foreign countries the art is said to be more advanced than it is in the United States. A gentleman who has had many years' experience abroad, however, assures us that while this may have been true in the past, American manufacturers are now more progressive than their foreign fellows. In some respects we believe this to be true, but in so far as training the practical welder is concerned, we believe Germany, at least, still excels. Their industrial schools are more highly developed than ours, but this may not be true a couple of years from now, as many schools and colleges are installing welding courses. Our manufacturers are also doing a great deal of educational work, with a resultant spread of practical welding knowledge.

Cost of High Speed Steel

THE decrease in the supply of tungsten, which came from Germany, is probably responsible for the high cost of high speed steel. In the event the war continues for an indefinite period we may expect high speed steel to be out of the market entirely. In the meantime shops may conserve their supply and at the same time effect a great saving by welding broken tools, as described elsewhere in this issue. The process described employs the use of oxy-acetylene apparatus, but this work is being done in many shops throughout the country by electrical machines. The Welding Engineer would be glad to hear from welders on this subject.

We Invite Correspondence

THOSE of our readers who have had practical training in welding and who may have had interesting and unusual experience will confer a great favor on their fellow welders by writing us. We should be glad to have for publication articles and photographs relating to welding by any process and we take this opportunity to invite correspondence.

THE methods you employ in your shop, the "jobs" you are called upon to do may be peculiar to the nature of business predominate in your territory and your familiarity with it may make it commonplace to you, but to others not so well acquainted with work of that class may present real problems which would be simplified by an expression from you. Don't be backward, tell us and others what you are doing—the welding profession is growing very rapidly and the profession as a whole will be benefited by free and frank discussion of "jobs" and problems and their performance and solution—BE A BOOSTER, HELP THE PROFESSION BY YOUR EXPERIENCE.

Increasing Efficiency of High Speed Steel

Short Pieces of High Grade Steel are being Reclaimed in Many Shops by Electrical and Oxy-acetelene Apparatus.

An interesting experiment in the welding of cutting tools to save cost has been in progress in the shops of the International Harvester Company. The oxy-acetylene process is used.

As shown in the drawing, a small piece of high speed steel is to be welded to a longer piece of tool steel, thus saving the cost of an entire tool in costly high speed steel,

Fig. 1. Shank of tool made of tool steel beveled for weld.

which itself if used is of such a structure that it fractures easily when used as a shaper or planer tool.

The shank of the tool, made of tool steel, is beveled in the manner shown in Fig. 1. Fig. 2 shows a section of the end of the tool steel shank, which measures two inches wide by one-half inch in thickness. The section of high speed steel which forms the cutting edge is not beveled or prepared in

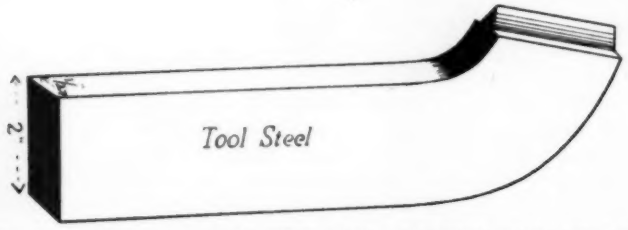


Fig. 2. Section of end of tool steel shank. The high speed section is not prepared in any way.

any way. It measures two inches in length, one and three-quarters in width and a quarter-inch in thickness.

These two parts are laid out as in Fig. 3, for welding. Each is previously prepared, however, by having a coating of special iron laid on the surface to be joined. This is done with as little melting as possible. The idea of a tinner in

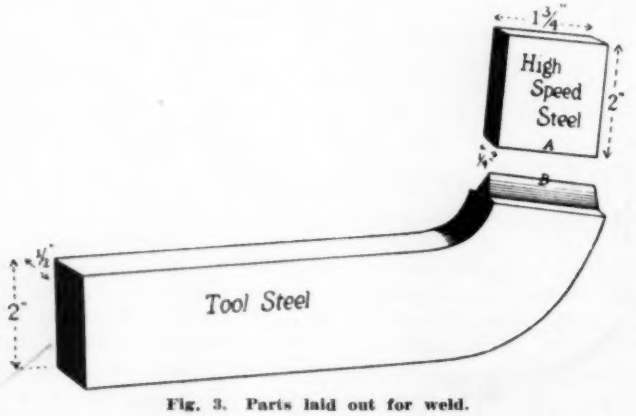


Fig. 3. Parts laid out for weld.

tinning the two surfaces to be soldered together in order to make the connecting solder stick to both surfaces is used. The layer of this metal need be only a sixteenth or a thirty-second of an inch in thickness and is put on with an absolutely neutral welding flame.

The channel between the two parts is now welded up with Norway iron, first on one side and then on the other, care only being taken not to keep the welding flame on the high

Fig. 4. Cross section of finished weld. Shaded portion represents added metal.

carbon steels any longer than necessary. In fact, from the nature of these planer tools it is not necessary to have a strong union between the Norway and the high carbon steels, as it will be seen from the cross section of the finished weld, Fig. 4, that the Norway iron added forms a socket for both

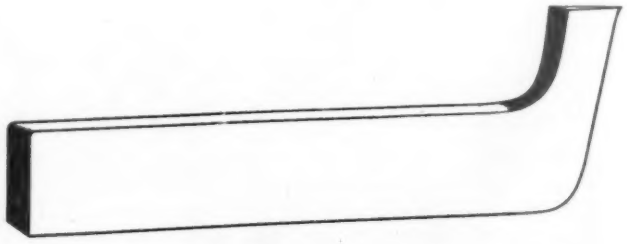


Fig. 5. The finished tool after weld. It's good for a lot of service.

the pieces to fit into. The shaded portions represent the added Norway iron. Fig. 5 shows the finished tool.

Tests of the finished tool were highly satisfactory, a 20 per cent failure was experienced on the initial lot and this has been greatly reduced since the tests have proceeded.

MALLEABLE IRON

Weld iron is a name occasionally used to describe malleable iron, indicating that it is pure enough to be welded. Malleable iron is produced by the puddling process. It is made by melting up pig iron and scrap in an open-hearth furnace and burning out the greater part of the silicon, manganese and carbon in the order named. As the burning continues the melting point of the iron rises and it becomes a pasty mass, permeated with slag from the stirring. This nearly pure iron is gathered into "puddle balls" and taken to the rolls at a white heat. It is rolled or hammered out into long strips. The strips are cut, reheated to white heat and welded together between the rolls or beneath the hammer. To procure the finest wrought iron, the process of rolling and welding is repeated. This is the puddling process in brief. Its object is to squeeze and work the slag out of the iron and to give the iron a fibrous structure like rolled copper.

The principal chemical difference between wrought iron and steel is the carbon content. In fact, except for its high carbon, basic open-hearth steel is purer than most malleable irons.

All weldable iron is not malleable, but it is weldable in proportion to its malleability. As is seen in the foregoing process, the iron is welded several times.

Economy in Gas Cutting

By J. F. SPRINGER

The Elasticity of Cutting by Means of Oxygen is Decidedly in its Favor. —Costs May be Reduced. However, by the Scientific Use of Gas.

While gas cutting of steel is extensively used in the United States, still it is doubtful whether we have done our share of investigation in respect to the economy of the process. As ordinarily carried out, gas cutting is expensive. Some years ago the writer recounted experiments in cutting miscellaneous cross-sections and arrived at the conclusion that the labor and gas costs for oxy-acetylene cutting amounted to about 1 cent per square inch of the face of the cut. This is probably a good deal more than the expense of cutting by means of hack and circular saws. One thing that makes gas cutting popular, in spite of its cost, is the elasticity of its application. The cutting torch may be taken into a mass of tangle steel and used to cut here, there and everywhere.

Of course, it is important to find out ways and means of reducing the expense in any considerable measure. Abroad, a good deal of attention has been paid to the possibilities along this line. I propose to give some account of results.

Before going into these details it will be well to have our minds clear as to certain main facts in connection with gas cutting. The procedure is understood to consist principally in a rapid oxidation of the steel. The force of the oxidizing jet drives off, or assists in driving off, the oxidized metal, particle by particle, as the oxidation proceeds. There are several oxides of iron. The one in question in the cutting process is the magnetic oxide (Fe_3O_4). As the atomic weights of iron and oxygen are 56 and 16, the weights of the two elements in the combination are in the ratio of 21:8. Consequently, knowing the weight of the iron (approximately the same as that of the steel) removed, the oxygen will weigh about 40 per cent of that weight. Now a cubic inch of iron weighs about 4½ ounces; so that a section 1 inch square and ⅛ inch thick will weigh 0.035 pound. Accordingly, the oxygen necessarily consumed in converting this metal into the oxide is 0.014 pound, or 0.1568 cubic foot. With oxygen at 3 cents per cubic foot, we have here a cost of about one-half cent. Now no matter what we do, we cannot hope to reduce this amount of oxygen. We may, of course, seek to get the oxygen for less than 3 cents and we may reduce the thickness of the section of steel removed to a point below ⅛ inch. This oxygen comes from the oxygen tank and only inappreciably from the atmosphere. Whatever weight of steel we remove, we must apply about 40 per cent of that weight of oxygen.

In fact, we must ordinarily supply more, because we can hardly expect to operate without some wastage. Investigation of the conditions of cutting may help us to minimize this loss.

A typical cutting torch has two separate jets, one immediately ahead of the other when the torch is in correct operating position. The forward one heats the metal to a high temperature—that is, to the temperature necessary for the combustion of the iron to Fe_3O_4. This is its duty, and about its only duty. This jet may be an oxy-acetylene mixture, or an oxy-hydrogen one, or some other mingling of gases, one of which will ordinarily be oxygen. The oxygen consumption due to this jet is not relatively considerable, except for the thinner cuts. The rear jet consists of oxygen, more or less pure. It supplies a cold stream of the gas at a rather high pressure, relatively. Here is where the heavy consumption of oxygen occurs. As oxygen is more expensive than acetylene or other usual fuel gases, the management, size, pressure and purity of the gas in this jet become of importance from an economic point of view.

The first thing to which attention is now called, with a view to promoting economy, is the temperature of the metal secured in the beginning by the leading jet and afterwards maintained partly by it and partly by the heat of combustion as the oxygen and iron unite. This temperature may be regulated within limits by adjustment of the heating jet. While the temperature of the metal should be high both at the commencement and during the work, still it is claimed in Europe that it may be too high. The temperature necessary for producing Fe_3O_4 is considerably below that of the melting point. If, then, the metal is actually melting as the cutting operation proceeds, the results are apt to be detrimental. If the heating flame is too strong, it may be carried down into the cut and there operate upon particles of iron already converted into the oxide and reduce them to metallic iron. Such particles clinging to the surfaces of the cut will need fresh oxygen for their re-conversion into Fe_3O_4. The demand for fresh oxygen involves a waste. **The heating flame should,** accordingly, **be maintained at just about the strength necessary to promote the advance of the cutting jet.**

Second, the width of the cut is an important consideration. As already pointed out, about 40 per cent of this weight must be supplied in the form of oxygen. If we multiply the weight, expressed in pounds, by 11.2 we shall have the minimum oxygen requirement expressed in cubic feet. Evidently, the narrower cut—other things being equal—the less volume of oxygen required. Some very remarkable results have been attained in this connection. Thus, Plieninger reports the following orifice diameters for the oxygen jet.

Thickness of steel in inches	Diameter of cutting orifice in inches	Calculated width of cut in inches
0.8	0.048	0.072
1.6	0.056	0.084
2.0	0.056	0.084

None of these widths of opening amounts to a sixteenth of an inch. The jet itself will be larger and the cut will be wider. Judging from figures found in a responsible source of information, the width of the cut will be about half again as large as the diameter of the orifice out of which the jet rushes. Even so, the 2-inch steel was divided by a cut less than ⅝ inch in width. But this is not all. Figures given for a special design of cutting torch indicate still narrower cuts. I give the figures in English measures.

Thickness of steel in inches	Width of cut in inches
1.2	0.040
2.0	0.048
3.2	0.060
4.0	0.072

Here the widths are much reduced. It is doubtful whether these figures have ever been beaten. As already said, the torch is of special design. The gases for the heating flame are made to discharge first of all as cooling jets upon the surface of the work, one jet to either side of the line of advance. These gases burn, but not until they have performed their duty in cooling either side of the work. Thus are provided two boundary lines for the heating and cutting. It appears to be sufficient to cool simply the upper surfaces, as evidently the cooling effects will not penetrate far. For a cut 2 inches deep by this torch, the gas consumption is quite moderate, being only 4.40 cubic feet per linear foot of cut for the oxy-

gen and 1.65 for the hydrogen. Presumably, the oxygen consumption includes the gas in the heating flame. The theoretical amount of oxygen for the 2 cubic inches of metal removed (2×12×.084) is 2.5 cubic. feet. If the oxygen was at all impure, still more would be required. If the cut were ⅛ in. wide, the theoretic amount of pure oxygen would be using the figures 0.1568 already given, 3.76 cubic feet. Here is a very tangible saving.

Now, it is very likely no more than the truth to say that the general run of cutting torches are unable to equal the performances of this special design. Still, let this principle be kept steadily in view: *Use the smallest oxygen jet possible.*

Third, there must be adequate pressure back of the cutting jet. The reason for this is not so much to secure a good strong impact—though this is important too—as to supply the necessary *amount* of oxygen. We have seen that a pretty definite minimum is required. There must at least be enough to secure the chemical combination. Now, as we reduce the diameter of the jet, we reduce the amount at a much more rapid rate. Other things being equal, when we cut the diamter to one-half, we cut the supply to one-fourth. The amount supplied varies inversely as the *square* of the diameter. The remedy—perhaps the only sufficient one—is to increase the velocity sufficiently. If we halve the diameter, we must increase the velocity fourfold. And the way to get velocity is to increase the pressure. The table already given, showing the diameters of jet orifice according to Plieninger for steel thickness of 0.8, 1.6 and 2.0 inches, states that these cuts would presumably be 0.072, 0.084 and 0.084 inch respectively. The proper pressures are 36.8, 61.7 and 66.2 pounds per square inch, respectively. Such heavy pressures are necessary in order to get enough oxygen through the orifices to do the work.

Fourth, economical cutting must pay more or less attention to the purity of the oxygen. If the gas is produced by the electrolytic process, the impurity will be hydrogen; if by the process which operates by the liquefaction of air, nitrogen. In the former case, the impurity is itself a fuel gas—and a very good one, too. The other impurity is an inert gas incapable of being burnt or otherwise utilized. In neither case is the impurity a substitute for oxygen. Consequently, if the oxygen is impure, more must be supplied to make up the deficit. Plieninger is responsible for the following. With oxygen 99 per cent pure a width of cut 0.118 in. was obtained. When the purity was reduced to 90 per cent, the corresponding cut was 0.138 in. wide. With oxygen at 80 per cent purity, the cut was 0.147. Of course, it may be that the saving in money in using oxygen more or less impure may altogether offset the advantages of using a very pure article. That is largely a question for individual determination.

Amedeo, a foreign investigator, gives comparative results for torches having separated jets and those having a central oxygen jet.

Cutting Oxygen Per Square Inch of Cut

	Cu. ft.
Oxy-hydrogen torch (separated jets)	0.253
Oxy-hydrogen torch (central cutting jet)	0.194
Oxy-acetylene torch (separated jets)	0.253
Oxy-acetylene torch (central cutting jet)	0.182

The same authority gives figures which show that with the heating jet the consumption of oxygen is very much less with the oxy-hydrogen torch than with the oxy-acetylene instrument. But this is more or less offset by the consumption of hydrogen—four times as great a volume of hydrogen as of heating oxygen is the amount required. It is probable that this heavy hydrogen consumption will, unless the hydrogen costs a very low figure, nullify the low oxygen consumption.

One of the principal European authorities gives a table which shows various matters relating to cutting. I reproduce a part of this table, but transfer to English measures.

Consumption of Cutting Oxygen

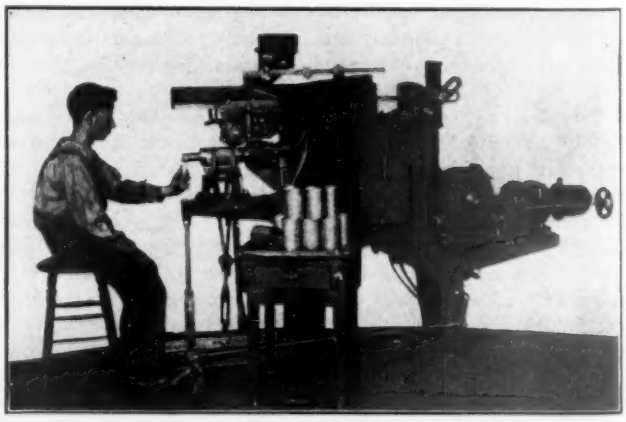
Thickness of steel plate. Inches.	Diameter of orifice for cutting oxygen. Inches.	Cutting oxygen necessary. Cubic feet of gas per linear foot of work. Cutting oxygen necessary. Cubic foot of gas per linear foot of work.		Time in minutes per linear foot of work.
		Oxygen 90% pure.	Oxygen 95% pure.	
0.2	0.020	0.22	0.25	1.6
0.4	0.020	0.43	0.54	1.6
0.6	0.028	0.76	0.97	1.8
0.8	0.028	1.07	1.35	1.8
1.0	0.028	1.35	1.62	1.8
2.0	0.040	4.05	4.86	2.1
4.0	0.040	7.56	9.72	2.1
8.0	0.048	21.60	24.84	3.1
12.0	0.048	30.24	37.80	3.1

The pressures are not given, but they are the pressures necessary to eject the quantities of oxygen in the times stated. The orifice for cutting oxygen is in all cases pretty small. We cannot expect to equal the economy in gas consumption unless we are able to do the cutting with the exceedingly narrow jets implied by the smallness of the opening in the tip.

Some reference has been made to what seems to be a very economical special design of cutting torch—the one capable of cutting 4-in. steel with a *cut* of 0.072 in. in width. There are three jets arranged parallel, side by side. These all move abreast as the cut is made. The tip comes to a sharpened end and through its point the cutting oxygen flows. The orifices of the other two jets—one to either side—are, because of the blunt taper, set a little further away from the work. These other jets supply the heating gas or the heating mixture. There is no ignition until *after* these jets strike the work. They operate, in fact, as cooling jets and limit the spread of the heated region where the cutting is accomplished. I do not know whether this type of torch is on the American market or not. It is protected in Germany by the Imperial German Patent No. 273,756. With this torch a very narrow cut can be made with consequent great economy in respect to the cutting oxygen.

ELECTRIC SEAM WELDING MACHINE

The illustration shows a new motor-driven seam-welding machine brought out by The Toledo Electric Welder Company of Cincinnati, Ohio. It is designed for rapidly welding cylinders made of sheet steel or lead coated stock. It will weld a 12-inch seam in five seconds and it leaves a perfectly smooth surface that can be enameled or finished in any way desired. The joint is water and gas tight. This process

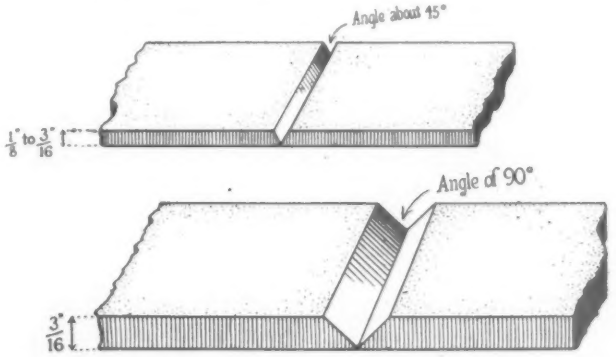


New Motor-driven seam welding machine built by Toledo Electric Welder Co., Cincinnati.

can be used in almost any place where it has been found necessary to draw the stock to shape. For example, in enameled coffee pots and burner cylinders for oil stoves or similar work.

WELDING IN A COUNTRY SHOP

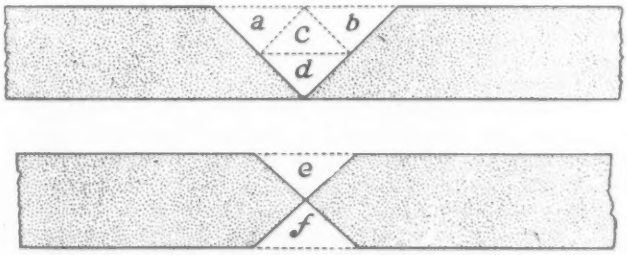
The statement has often been made that outside of big city shops, where jobs of every sort are daily making their appearance, there are comparatively few all around welders in this country. By "all around" welders we mean workmen who are qualified by experience to undertake to weld any job; men who are in fact familiar with the characteristic tendencies of all metals. Many welders are found to be very familiar with the necessary treatment of aluminum crank cases, for instance, and at the same time possess but a slight knowledge of the proper treatment of cast iron.



Parts to be welded should be beveled if more than ⅛ inch in thickness.

Up to a few years ago, before the onslaught of the automobile in fact, country blacksmiths had very little experience in the welding of cast iron and hard steel, and absolutely none in aluminum. The country smith was called upon to weld such items as tires, plow-shares, etc., in fact articles made principally from wrought iron. In these days, however, and since the local blacksmith has found it necessary to replace a diminishing horse-shoeing business with an auto and general repair business, it is necessary for him to understand the characteristics of all metals used in the manufacture of automobile and farm implements, for instance.

As an illustration of what country smiths are doing the story of an experience of a traveling salesman for one of the apparatus manufacturers is interesting. The salesman had



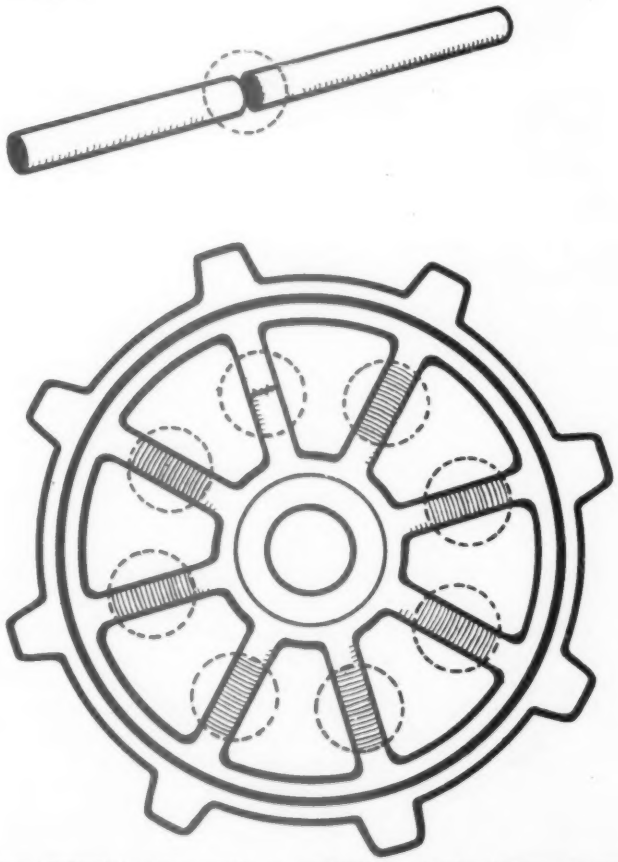
Pieces of great thickness should be beveled both sides. Work is facilitated and a 50 per cent saving made in filler rod.

received a request for information and prices from a point in a Western State. Reference to a time-table disclosed the information that the town in question consisted of a side-track and a small freight house. Nevertheless the salesman stopped off at this point, only to find that his prospective customer lived on a farm two miles from the depot. Not to be daunted the salesman trudged out to the farm and was rewarded with an order and a good supper, and a ride back to the depot in the farmer's automobile.

It seems this farmer has a small building on his place he uses as a blacksmith shop. He himself is something of a mechanic and his one farm laborer is always selected partly for his ability to set a shoe or do some other repair work in the shop. The farmer had heard something about the new process of repairing broken machinery by the use of oxy-acetylene apparatus, so he asked for information. Piled near his shop he had a quantity of broken parts from farm machinery, some of which can be repaired and put back in service, and all of which could have been reclaimed at a big saving at the time they were broken. This farmer expects to do considerable oxy-acetylene work for his neighbors and customers and will undoubtedly find the equipment to be the best investment on his place.

At the beginning this man and his assistant understand perfectly the treatment of "weld" iron, but they know little about hard steel, castings, aluminum, etc. The success they will have depends much upon the intelligence displayed in the study of metals and the preparation of the work or job itself.

It has been said that a job well prepared is half finished, and most assuredly time spent in the study of metals and the proper preparation of the broken parts to be welded is time well spent.



Bar illustrated above needs no preheating. Spoke broken in gear wheel could not be welded unless each spoke was preheated as indicated by shaded circles. Whole wheel should be preheated if cast iron.

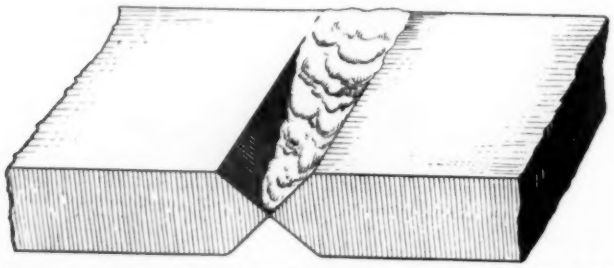
At the beginning it should perhaps be pointed out that the flame from a welding torch, properly adjusted to give the correct flow or mixture of oxygen gas and acetylene gas, produces twice the heat necessary to melt steel. Iron and steel may be welded without the use of flux, but in welding cast iron, aluminum parts, bronze, brass, copper, etc., a flux is necessary. Iron and steel may be butt welded; that is, the metal may be brought to the fusing point and a union secured without compression or hammering, but the use of "filler" rods are necessary when work is being done on other metals.

As we have said before, a first-class mechanic may become familiar with the torch very quickly but much depends upon the preliminary preparation. By preliminary preparation we mean cleaning, beveling, preheating and stationary adjustment of parts to be welded.

Cleaning may usually be done with the torch and it should be borne in mind that the parts to be welded do not require the same treatment as for brazing or soldering. If the parts to be welded, however, exceed ⅛ of an inch in thickness, they

should be beveled; that is cutting so as to form an angle which enlarges the line of joining and permits the addition of a much larger quantity of metal of a much better quality. The flame is also admitted more readily to the bottom of the weld, which permits beginning the weld at the bottom and building up. Beveling for parts ⅛ of an inch to ¼-in. in thickness should be about 45 degrees, while for pieces exceeding ⅜ of an inch the bevel should be about 90 degrees. Pieces of great thickness may be beveled on both sides, which facilitates the work.

In most cases cast iron, aluminum, etc., should be pre-



Welding in steps is preferable, which prevents cooling of metal before fusion.

heated before welding, to take care of expansion and contraction. All weldable metals and alloys expand when heated, with a corresponding contraction when cooled. Take a metal wheel as an illustration. If it is desired to weld a broken spoke in the wheel the other spokes must be preheated, so that they will expand equally with the spoke which is being welded, otherwise the wheel will either be broken or distorted. Preheating and annealing is an involved subject and one which should not be treated lightly and it is the author's intention to present for the consideration of readers in the February issue, an article on preheating.

IMMENSE BOILER SHEETS FABRICATED WITH WELDING BLOWPIPE

An interesting example of the oxy-acetylene blowpipe's utility for general manufacturing purposes, is shown in the accompanying photograph of two large steel tube sheets for a marine type boiler, made by welding together two plates of heavy 1-in. rolled steel. It was essential that the finished sheets be 151 inches in diameter, and, as the largest plates

Welding of one-inch plates to make sheet 151 inches in diameter.

rolled are stated to be but 142 inches in width, it was necessary in this instance to provide a satisfactory means of joining on an additional 9-in. strip of metal. The blow-torch filled this need.

There were two factors which entered to make this job difficult: That the circles were of such large size, hence awkward to handle; and in the welding it was essential that the added strip be held in the same plane.

Each plate required about 6 feet 2 inches of lineal weld, and, as both sheets were flanged when assembled, the line of weld meets a certain strain. Also 3½-in. tube holes were drilled in the completed sheets, some through the weld itself. This would likewise put the weld under test.

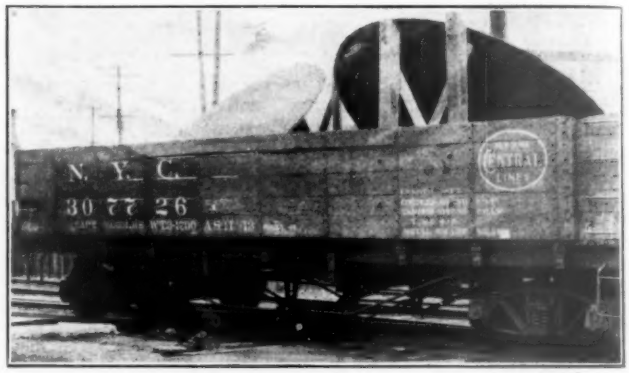
A SAVING IN BRASS AND COPPER

The increasing price of brass and copper has threatened destruction to many manufacturers who manufacture articles made from these materials. Many are escaping by manufacturing these articles from steel and, since they cannot work the new metal in the same way as they did the former, many new machines are being called for.

A concrete example of the change is shown in the manufacture of metal mirror frames and picture frames, which were formerly made from brass strips soldered with silver solder in the form of a hoop, then die pressed to form the frames.

In using steel for this purpose the hoops, to be strongly and accurately joined, must be electrically welded, as no other process compares with this weld in speed, accuracy and strength. Being automatic in action, every weld is made with the same heat, the same compression and the same efficiency.

The machine for work of this kind consists of a cast iron frame in which is installed a transformer, on the terminals of which are mounted copper platens fitted for water circulation. The clamping device is mounted on the platens, the left-hand platen is adjustable by a screw at the left to



Large plates welded and loaded on car.

any required opening between the clamping arms and is bolted directly to the one terminal while the other slides on the other terminal of the transformer.

The upper contacts are of self-hardening steel and are operated by the cams from the main shaft run by a clutch pulley which enables the operator to start and stop the machine by means of a foot treadle.

Using an 8-inch pulley, run at a speed of 40 revolutions per minute, 600 complete cycles are made per hour and, if stock is fed to the clamps at every cycle, the machine is capable of a production of 600 welds per hour.

In operation the right platen moves away from the left, increasing the space between the arms of the clamping device, and the jaws open while the operator places the two ends of the strip on the copper electrodes, the joint being midway between.

The clamping jaws come down, holding the two ends firmly, the switch closes, the steel heats and as it softens the pressure causes the two platens to move together, upsetting the metal at the joint and making the weld. The steel jaws then lift up, the work is removed, the new pieces inserted and the operation is repeated. Being adjustable as to amount of current and time consumed, an accurate and reliable work is assured. A machine to do the same work, but operated entirely by hand, is manufactured. This machine is capable of from 300 to 400 welds per hour.

The current cost for welding steel bands of .032 inch thickness by one and three-eighths inch width, the usual size, costs only 75 to 80 cents per 1,000 welds.

By using a bright finished steel a plating surface equal to that of brass is said to have been obtained and after the gold lacquer is applied it is impossible to tell which metal has been used for a base.

OVER A MILE OF VERTICAL WELDED PIPE

Drillers of Gas and Oil Wells Learn From the Deep Well Installation at McDonald, Pa., of Remarkable Advantages to be Obtained by Welding the Casing—Details of Work

A welded pipe installation which presents some very interesting new features and which opens up a hitherto unknown field of great possibilities is reported from McDonald, Pa. Near McDonald, the deepest well in the United States and second deepest in the world recently was completed at a depth of 7,181 feet, every joint in its casing being welded by the oxy-acetylene process. This work was commenced by the Pittsburgh office of the Oxweld Acetylene Co., of Chicago, for the Peoples Natural Gas Co. of Pittsburgh, on September

Welder at work on pipe for oil well.

1st and was completed on September 29th. It did not, of course, require all of this time to do the welding, the above period covering all delays, etc., while part of the time one of the welders was doing other welding at nearby points. This well is known throughout the gas and oil fields of the United States as "the deep well," its one rival being one of 7,300 feet, in Galicia, where the European fighting now is going on.

The object in drilling this well is the desire of the owners to get to a known sand, which at this point is estimated to lie 8,000 feet below the surface. The size of the hole is 13 inches, 10 inches, 8¼ inches, 6⅝ inches and 5 inches. In other words, after drilling a 13-inch hole a certain distance, the contractor reduced it to 10 inches, then tapering at two subsequent jumps until at the very bottom it is 5 inches.

Welds Sustain Enormous Weight

The actual weight of the casing in this hole is 45 tons. F. R. Goehler, Pittsburgh representative of the Oxweld Acetylene Co., says: "In doing this work, we had the ends chamfered to 60 degrees to give us a chance to make a good deep, wide weld, and we built the welds up to ¼-in. reinforcement all around. All of this casing was in 22-ft. lengths. The first 250 ft. was 5¼-in. O. D. with ⅜-in. walls, or thickness, and the remainder, or 6,071 ft. of casing, was 5 in. O. D. with ¼-in. walls.

Method of Welding and Lowering

Two lengths of the casing were welded together in the yard, then hoisted into the derrick and lowered. About 5 ft. were kept above the floor of the well, supported by steel wedges, placed between the casing and the steel block through which it was lowered, as shown in the photograph. Then two more pieces, welded together, were hoisted, butted up against the last lowered casing and welded. The weld was permitted to cool sufficiently to permit the placing of the hand upon the weld before the wedges were removed, and the casing lowered, to permit of the operation being repeated. At the top of the derrick we put across a plank with a half circle cut in one side, against which the upper end of the pipe was held while the lower end was welded. This was done to insure absolute alignment of the pipe when welded, one of the vital things in this work being to have an absolutely straight casing. Otherwise the wire on the drill tools, working back and forth while drilling, would gradually cut the casing where it interfered.

Plugs Partially Buoy Up the Pipe

"At the bottom of the well there was a great deal of salt water, the pressure being estimated around 3,000 lbs. In the first length of the casing lowered, we placed a wedge, or 'shoe,' same being an oak plug about 3 ft. long, driven into the end of the casing and then soaked in water. This shoe was put in so that the salt water might buoy up the pipe which was being lowered before the welds were cool, and thus take as much strain from the welds as possible. It was intended to drill this plug out after the casing was all lowered, but when about 2,500 ft. of casing had been lowered, this plug blew out with terrific force, shaking the ground around the well for a considerable distance. As a result of this, we had to place, in the next piece of tubing that we welded, a plug with a small steel ring in back of it to hold it. After the entire 6,321 ft. of casing was in place, this ring and plug were drilled out.

Space Saved by Welding Process

"Prior to the welded casing experiment, the company had used a string of heavy casing, with screw fittings, the ends upset, having a screw fitting, while back of the upset parts on each end were two collars, which were fastened together with bolts. All of this was necessary to hold the casing together, as the screw fittings themselves could not do this. Necessarily, these upset ends, bolts, etc., took up considera-

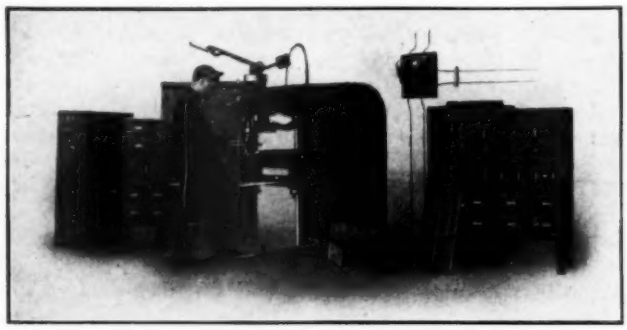
Two lengths were welded in the yard and then hoisted and lowered.

ble room and did not permit of a casing with a very large inside dimension. One of the big advantages of welded casing was the doing away of these screw fittings, collars and bolts, permitting the use of a larger casing, with resultant larger interior opening.

"Without hurrying, the welds were done in 25 minutes each, while 15 to 20 minutes was permitted for the necessary cooling."

ELECTRIC WELDING AT THE GLOBE PLANT IN CINCINNATI, OHIO

The Globe Wernicke Co. of Cincinnati, Ohio, are the largest manufacturers of office furniture, portable steel safes and sectional bookcases in the world. Within recent years they have brought out a complete line of sheet steel office fittings, and have a unique way of advertising their product. Every salesman is furnished with a sample of sheet steel electrically welded. The first thing he does is to produce the sample and explain how it is spot welded instead of being riveted. The prospective buyer is asked to tear it apart—smash the "bally" thing with a hammer or give it any old test he wants. When the prospect has tired himself out in wielding a sledge hammer and finds that the welds won't break, it's an easy matter to convince him that no matter what happens to a Globe Wernicke steel cabinet, the welding will not break or separate, and this construction will last for centuries.



The manufacture of the "Globe" steel filing cabinets.

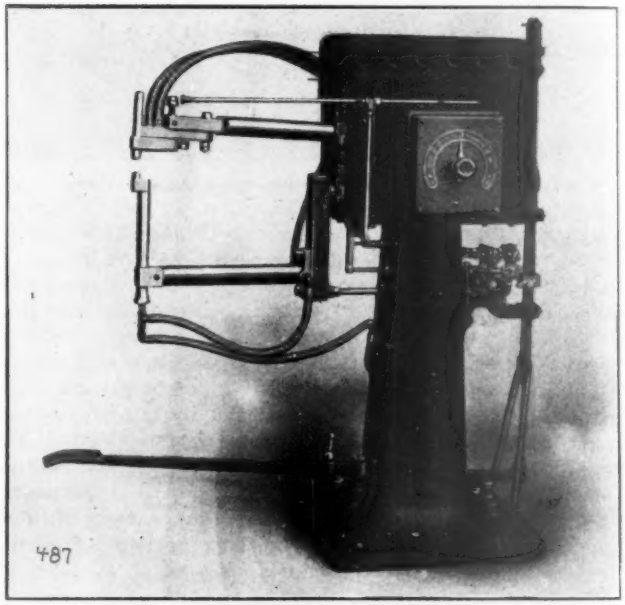
The illustration shows a boy welding drawers in filing cases on a spot welding machine. As quick as electricity can jump through the two pieces of iron, it is heated to the welding temperature, the metal is softened and pressed together and the whole operation is instantaneous. When a colored porter was asked if his train stopped at a certain place, he replied: 'No, sah, we don't even hesitate." So it is with spot welding, it don't even hesitate. As only 3 to 5 volts are used in making a weld, the machines are as safe to operate as the dry cell used for ringing a door bell.

The machine illustrated is only one out of a dozen or more that are working night and day. Several smaller machines are used similar to the one shown below, but the operation of the machines is on the same principle.

The Globe Wernicke Co. have a large direct-current power equipment, and to get the alternating current required, they installed a 75-K.W. A.C. 3-phase, 220-volt generator, driven by a direct-current motor. The load is distributed over the 3 phases and by means of a special device furnished by The Toledo Electric Welder Co. there is no appreciable drop in voltage even when the full capacity of the largest welding machine is thrown on the line.

GAS COMPANIES ARE WELDING

Some very interesting experiences with the oxy-acetylene process recently have been reported. Chas. B. Gamble, assistant superintendent of the Minneapolis, Minn., Gas Light Co., describes his experience with a welding outfit as follows: "During the past summer six of our benches of nines were refilled and on all of them the iron work was in bad shape. It was decided to try to make repairs on the mouth pieces with an oxy-acetylene outfit. Before the benches were let down some experiments were tried to determine the most efficient method of doing this work and in spite of the high price of welding rod it was decided that the filling method would be the most efficient and call for the least expenditure. The mouth pieces, like all of this class of iron work that has been worked on a hand house, were worn thin on the bottom and in some cases cracked. To preheat the piece for repair, a temporary fire brick cover was built around it and a fire of coke placed on the inside. The bricks were laid up dry and the fire blown with a gentle blast of air. Three of the pieces were heated at the same time giving the welder a day's work without any waits. So that the welding could be done in the day time the mouth pieces were set up in the afternoon and the fire brick cover placed around them. At about six in the morning one of the night men was delegated to start the fires and the blast. Usually the iron was ready for the welder at eight o'clock when he came to work. The average cost of these repairs was about $5.00 per piece. Considering the fact that many of the mouth pieces had large pieces broken out of the bottom and all of them would have been scrapped, we consider that the saving effected quite repaid us for our experimenting. Fifty-four mouth pieces were repaired in this way. Carrying our experiments still further we discovered that a mouth piece could be repaired without removal from the bench if it was broken while the bench was under fire. To make this repair, a pan for the preheating of the part is placed under the mouthpiece filled with hot coke and blown by means of a motor driven blower. The front of the retort is bricked up to protect the operator and the repair is a rather simple one though rather hot on the man using the torch. We have made a number of such repairs at an average cost of about $4.00 and an average time out for the retort of about 3.5 hours. On the stand pipes a considerable saving has been effected by welding short pieces of pipe to the ends next the mouth piece. The cost of this work is very small in comparison with the cost of a new pipe although I have no reliable data as to the exact amount. This work was done during such times as the mouth pieces were not in proper shape for welding and the welder would have a half hour or so to devote to it. The torch was also used to make repairs on the steel cottar bars of the lids. This work was done by filling the hole that had worn with a piece of round mild steel and then welding it in place. The proper sized hole was afterward drilled in the plug. Of course there have been numerous other pieces of work done by the torch but the above comprises the largest part of what we have done since buying the apparatus. We feel that this year's work has demonstrated that the oxy-acetylene torch is an indispensable gas works tool and even in a works much smaller than our own would amply repay the investment."



Spot welder in use by the Globe-Wernicke Co., manufactured by The Toledo Electric Welder Co.

Gets Tight Lines at Lower Cost

J. D. Shattuck, general manager of the Philadelphia Suburban Gas and Electric Co., at Chester, Pa., has been using

acetylene welding. Mr. Shattuck has done considerable of this work for the last four and a half years and all of his high pressure work as well as some of the low pressure inside work is now done with oxy-acetylene welding. His costs for laying mains this year show a lower average cost with welded mains than the screw lines of previous years. "We are not only saving money by welding," says Mr. Shattuck, "but we are getting **tight lines.**" Mr. Shattuck, it will be remembered, covered this subject before the American Gas Institute in considerable detail in October of 1914.

Fourteen Miles at Springfield, Mass.

A. S. Hall, superintendent of the Springfield (Mass.) Gas Light Co., says: We have laid about 14 miles of 4-in. and 6-in. welded pipe this season, and it seems to be giving very good satisfaction so far. We are still working on these lines and may have some interesting figures on this work later.—The Gas Record.

METALS ELECTRICALLY WELDED

As proof that other metals besides iron and steel have been and can be welded by electricity, the following list of metals and their alloys and combinations have been compiled from a list of articles which are being commercially welded today:

Metals

Wrought iron	Manganese	Lead
Cast iron	Silver	Bismuth
Wrought copper	Nickel	Platinum
Tin C	Zinc	Tungsten
Cobalt	Antimony	Gold

Alloys

Mild steels	Crucible steel	Fuse metal
Tool steels	Nickel steel	Gun metal
Mushet steels	Chrome steel	Silicon bronze
Stubs steel	Bessemer steel	Type metal
Cast steel	Wrought brass	Aluminum iron
Aluminum brass	Aluminum bronze	Monel metal
Coin silver	Phosphor bronze	
Brass alloys	Gold alloys	

Combinations

Copper to brass	Gold to platinum
Brass to wrought iron	Wrought iron to Mushet steel
Brass to tin	Wrought iron to Stub's steel
Copper to German silver	Wrought iron to Crescent steel
Tin to zinc	Wrought iron to cast brass
Copper to silver	Wrought iron to German silver
Tin to brass	Wrought iron to nickel
Brass to German silver	Wrought iron to Monel metal
Brass to platinum	Tin to lead
Brass to mild steel	Mild steel to tool steel
Wrought iron to cast steel	Nickel steel to Mach. steel
Wrought iron to mild steel	Silver to platinum
Steel to platinum	Monel metal to platinum
Wrought iron to tool steel	Monel metal to tungsten
Gold to German silver	Brass to tungsten
Gold to silver	Steel to tungsten

WELDING IN THE PULLMAN PLANT

The Pullman Company, manufacturers of all-steel railroad cars, in developing methods of manufacture have come across some problems which are of great interest to all manufacturers of steel girders and sheet steel boxes, tanks and receptacles.

The long steel girders forming the sills of the cars are to be tapered at either end. A section is therefore cut out and the cut edges brought together, to be welded by the electric arc.

Experiments conducted through a considerable period demonstrated that considerable savings could be made in this operation by using two welders working from both sides at the same time, and also by channelling the steel for welding from both sides.

Figure 1, showing a cross section of the steel girder, demonstrates how a saving was made in the amount of material cut away with the pneumatic chisels and, of course, in the amount of metal necessary to replace in the weld.

In Case A, where the weld was to be made from one side only, the metal removed is 50 per cent more than the metal removed in Case B. The weld made in Case A with a single electrode took a 5/32-inch metal electrode, requiring about 120 amperes, at a welding rate of one and a quarter feet per hour, or 5.5 kilowatt hours per foot. By using a larger electrode requiring 200 amperes, the speed of welding could be doubled, but only at the expense of strength in the weld, which rendered it impracticable.

In Case B, where the weld is made from both sides, there is much less material to fill in, as will be seen from the drawing. A 5/32-inch metal electrode in this instance, using 120 amperes proceeded at the rate of a foot in 10 minutes or 6 feet per hour on a single groove or 3 feet per hour on the double groove, or at the rate of 1.2 kilowatt hours per foot, not counting the time consumed in changing from one side to the other or in turning the work over.

Since with metallic electrodes the work may be done in any position, and since with two welders, one on either side, the work would go forward at the rate of six feet per hour, or 1.2 kilowatt hours per foot, without taking into account the use of the two heats at the one time, which aid each other in preheating ahead of the weld, it was found that two average operators can increase their speed 50 per cent or between 9 and 10 feet per hour.

It is therefore apparent that the quickest, cheapest and strongest weld can be made by working two operators at once.

A carbon electrode could be used where time was the principal object. Using twice the current, the ⅝-inch weld could be made at a rate of 2½ feet per hour or about 5.5 kilowatt hours per foot.

The strength of the welds under test was found to be equal to the strength of the original beam before being slotted, a slight additional metal added above the surface of the weld probably being responsible.

In the welding of heavy steel pressure tanks for other purposes it was found that welding from both sides at one time presented a saving from 25 to 50 per cent. With oxy-acetylene on ⅜-inch boiler plate an even larger saving was made, by welding both sides of the seam at the one time. A greater efficiency in the weld was also apparent on examining a magnified section, a closer union of the fibers and less flaws were apparent.

The explanation, of course, lies in the fact that there is less heat necessary to bring the metal to the welding heat and therefore less chance of burning at any one spot. Some credit must also be given to the fact that the team work demanded causes the two operators to work more steadily, so that one may not lag behind.

A large boiler and tank works, which by accident set two operators to work on one tank, welding from opposite sides, found the weld so much more even that the method is used entirely and would not now be dispensed with.

Gender, Paeschke & Frey Co., Milwaukee, have recently issued a circular descriptive of a machine used in manufacturing automobile rims and heavy wagon tires. This machine is the Cream City butt welder, made in both hand-lever operated type and also the hydraulic type for heavy work, the largest of which will take a tire 6x¾".

Campbell & Rickel, Minneapolis, have issued a circular descriptive of "Torit" welding apparatus, as manufactured for them by Evleth-Lindsay Company, Inc. Welding and Carbon Burning Torches, as well as oxygen and acetylene regulators, are described.

THE VALUE OF PURE OXYGEN AND THE OXY-HYDROGEN CUTTING PROCESS

By H. J. Mueller, Vice-Pres. Universal Oxygeu Co

The cutting and welding of metals by various gases combined with oxygen, in suitably designed apparatus, has in many ways revolutionized a great many phases of work in practical lines of the steel and iron industry during the past few years, and a continually increasing field has been developed. Until recently these processes of cutting and welding were used only on special occasions where the conditions were such as to prevent the work being done by any of the ordinary methods, and the process was regarded as a luxury to be used only on such special occasions, the reason for this being that the manufacturer's equipment was not constructed efficient enough, nor was the demand large enough, to enable him to produce the gas in large quantities and sell it at a price so that the trade could take practical advantage of it. However, great improvement has been made by the manufacturer as to producing the oxygen as well as the hydrogen at a cost so that the process can be used to great advantage in the general metal industry.

The oxy-hydrogen cutting was also known as being expensive compared with its competitive gases, as hydrogen was usually sold for $2 per cwt. in small quantities and $1.50 per cwt. in large quantities. However, since the demand of the hydrogen was constantly increasing, it gave the possibility for the manufacturer to produce the gas for considerably less cost. Pure hydrogen gas of 100 per cent can today be purchased in small quantities for $1 per cwt. cu. ft. and in large quantities as low as 60 cents per cwt. cu. ft., which of course, makes it possible for this process to be used for any kind of cutting such as Scrap Iron, removing risers from Steel Castings, as well as Structural Work, etc., and the trades were quick to realize the essential advantages of the practical use of the process in an ever-increasing line of work, and gradually became large consumers of gases.

With the various gases used in the cutting flame, Oxygen is the really important gas, as it imparts the necessary heat to the flame, as it is by means of Oxygen only that cutting can be effected.

There are various ways of generating Oxygen commercially; the Electrolytic process, the Liquid Air Process, and the various chemical processes have all contributed their share toward the supply of good, bad and indifferent oxygens. Very few users of Oxygen, however, take into consideration the advantage of using pure Oxygen as they seem to adhere to the general belief that any old Oxygen will suffice so long as it is called Oxygen, although laboratory tests of Oxygens of various degrees of purity have shown conclusively the wide variations in results obtained by these different oxygens. In order to produce the best results, Oxygen must be free from inert gases and various impurities such as nitrogen and chloride matter. Exhaustive tests have proven that for every percentage of increase of any of these impurities, the percentage of efficiency of the Oxygen is decreased many times. It is also reasonable to expect that the higher the quality of the Oxygen, the greater will be the initial cost of production. It may seem to the ordinary user of Oxygen that the cost per cubic foot naturally should be the same, no matter whether he has a pure or an impure oxygen, as he doesn't know the difference if he has had no experience in using pure oxygen. An experienced operator, however, would not care to use anything else than pure Oxygen in order to accomplish his work as he knows that the benefit of using same is enormous. This is proven in the writer's experiment and Gas Table given further on.

The presence of even small quantities of inert gases, such as nitrogen, chlorine matter and other chemical impurities, have a marked tendency to prevent the direct action of the stream of oxygen upon the molecules of iron, with the result that the cutting will be irregular or spasmodic, while greater amounts of impurities so retard the action of the oxygen, that oxidation or cutting is practicably impossible. Impure gases, such as nitrogen and chlorine matters will also crystallize the metal when they are used for welding and this can all be remedied if the customer realizes what pure Oxygen means when used in connection with his work.

In order to arrive at the many theories regarding the difference of opinion relative to the effects of different grades of Oxygen, an extensive series of tests covering a long period, and showing conclusively the relative differences in Oxygens for cutting, have been conducted.

The following test was made for the purpose of determining the action of various grades of Oxygen in cutting 1" open hearth steel plate:

The different grades of Oxygen used in the test were taken from steel cylinders each charged to a pressure of 120 atmospheres, and the volume of gas in each cylinder was ample to cover any possible reduction in pressure or velocity due to a diminishing gas supply while the relatively small percentage of the cylinder's contents were being used.

TABLE

Record of cutting test on 1-in. thick Open Hearth steel plate, cut 60 in. long, using oxygen of different percentages of purity.

Test No.	Gas Purity	Length of cut	Time in seconds	Oxygen used in cu. ft.	Increase in percentage of cutting time	Increase in percentage of oxygen used	Remarks kind of cut
1	99.7	60 in.	280	8.0	0.0	0.0	Very smooth and clean cut.
2	99.4	60 in.	291	8.8	3.9%	10.0%	Smooth cut.
3	99.1	60 in.	315	9.8	12.5%	22.5%	Fair cut.
4	98	60 in.	334	11.3	19.3%	41.0%	Good cut, but rather ragged.
5	96	60 in.	365	13.2	30.3%	65.0%	Unclean cut.
6	95	60 in.	412	15.4	47.0%	92.5%	Very irregularly cut.
7	90	60 in.	644	20.0	130.0%	150.0%	Rough and oxydized cut.
8	87	60 in.	675	23.0	141.0%	187.0%	Very rough and oxydized cut.
9	85	60 in.	696	25.8	148.0%	222.0%	Very rough and choky cut.
10	82.5	60 in.	not recorded	28.4		225.0%	Very rough and not cut thru.

The apparatus used for performing this work was a straight line cutting machine, in which the movement of the cutting nozzle was actuated by a longitudinal screw feed.

The same cutting nozzle was used in each instance, and the supply valves on the regulators, were properly adjusted for the first cut, and were not changed in making any of the subsequent cuts, the gas outlet being opened or closed by an entirely separate shut-off valve.

The test strips were cut from the same sheet of 1" open hearth steel, and in each separate test, three individual cuts were made, and the average taken as the basis for the figures in the table following. In fact, the test was a very tedious job but the knowledge gained by noting the different actions between the pure and impure gases was each an interesting study that nothing was left undone to secure the figures of the positive advantage of pure Oxygen.

To anyone technically interested in the relative values of different grades of Oxygen, the results proved beyond a doubt the fallacy of the generally contended opinion that slight impurities in the Oxygen were of no consequence in general work.

Making a careful note of the results obtained in cut No. 1, it is interesting to note that in cut No. 3 the increase in Oxygen consumption was 22%, and the increase in time required 12%, although the purity of the Oxygen was only 0.6% less.

Taking cut No. 5 as another instance, you will note the purity of the Oxygen was 96%; the Oxygen required was 65%

in excess of that required for cutting No. 1; and the time required was 30% longer.

In cut No. 7 the increase in Oxygen consumption was 150%, with an increase of 130% in length of time required, in which case Oxygen of 90% purity was used.

In cut No. 10, using 82.5% purity, it was found impossible to entirely cut the sheet, although 255% more gas was used to produce the best results obtainable.

Aside from the important factors of amount of gas required and time necessary to produce the above results, the physical aspect of the cut was one of greatest importance, as the above table will show.

It is false economy to use Oxygen which can be purchased or manufactured from 20% to 30% less than the cost of an absolutely high grade gas, when the great difference in results is so manifest, and to any user of Oxygen in any quantity the above facts ought to be of prime importance.

The importance and advantage of the Oxy-Hydrogen Cutting is that the apparatus used in connection with same is light and easily transported as only two small tanks are necessary, which approximately weigh about 145 lbs. apiece and in which the gas is compressed to a pressure of 1,800 lbs. equal to 200 cu. ft. for both oxygen and hydrogen. These tanks are further equipped with a reducing valve, necessary hose, and the cutting torch. This apparatus is usually put on a truck and thus allows the operator to move more easily on the job.

A great deal of experience is not necessary in order to operate this equipment. The tanks are opened and the reducing valve is set for the proper pressure; the hydrogen gas is lit and sufficient oxygen is mixed with the heating flame. An extra stream of oxygen is forced on the metal after it has been heated to the proper temperature, which immediately has an oxidizing effect, thereby cutting the metal. There are numerous constructions of cutting torches on the market, which, of course, also have been greatly improved as to their efficiency and mechanical appliance in regulating the flame as well as the oxygen. The gas can be used either in hot or cold weather, as there is little danger should it be subjected to extreme heat or cold, as these gases are absolutely dry and not in a liquid state when compressed. This, however, is not the case when using generated gas, as the generator can easily be overheated or frozen, if it is not properly watched and taken care of.

The Oxy-Hydrogen flame will also oxidize a good deal more rapidly than any other flame known, as it does not contain any carbon and is simply a pure vapor flame which heats and oxidizes the metal rapidly, and which allows the oxygen to act freely, thereby obtaining a smooth cut.

This flame is also used to great advantage in cutting scrap iron, as the flame does not flash back into the torch as easily as the oxy-hydro-carbon flame. This disadvantage of the oxy-hydro-carbon flame clogs up the tips and decarbonizes the passes for the gas and needs continuous attention by the operator. The superiority in cutting scrap iron with the oxy-hydrogen flame is of great advantage as to this point alone, as the operator who has done cutting in scrap iron yards and has had a chance of cutting up an old scaly, rusty boiler, will realize this all-important advantage as being free from having flash-backs in the torch, burning up tips, etc.

These gases also have no offensive odors, as they are made in most cases from absolutely pure water which has been distilled and are also the healthiest gases for any operator to work with. The carbon gases usually have a bad odor and the workingman does not care to have anything to do with them, as they have in a great many cases been injurious to the health of the operator.

The hydrogen flame does not strain the eyes as the carbon flame does, as the hydrogen is a yellow flame, whereas the carbon flame is a bright white flame and has a similar effect on the eyes as the carbon arc light.

When doing accurate cutting work, such as structural steel, holes in boilers, or any shape cuts which might be required, the oxy-hydrogen torch is of great importance. By mounting the torch on a mechanical feed arrangement the cuts can be made as smooth as any saw cut.

RECLAIMING DIES

The Pollard Engineering Company of Chicago, die and toolmakers, have been experimenting on the welding of dies by the oxy-acetylene process with favorable results.

The die in which most interest centers from the welders' standpoint and also from the diemakers' standpoint is a sheet metal cutting die, about an inch in thickness and of irregular shape with an average diameter of about three inches.

These dies are made from H. & R. steel and afterwards hardened by a water dip. The usual need for welding comes from the action of a cutting tool in outlining the circumference, which sometimes pulls out a portion of the body of the die in starting the cut.

To weld in a section to take the place of the flaw is the problem confronting the welder.

The work in this case was performed by H. E. Collinet of the Able Machine Works, also of Chicago. The process is briefly described as follows:

Since this grade of steel starts to lose its carbon on passing a red heat, the cavity is heated with the oxy-acetylene torch to a red heat, care being taken that at no point does the steel approach the white or flowing heat. At this point a suitable welding of rod of high carbon steel containing more carbon than the die is melted as quickly as possible into the cavity and the whole surface smoothed off with as little melting of the steel as is possible.

The Pollard Engineering Company reports the dies thus welded to show a perfect union of the die steel with the welded added portion and that portion of the added material exposed as a cutting edge of the die to be standing up under the continuous use, as well as the original material of the die.

The dies are machined as they come from the welder without any annealing or preparation, and when they are done are hardened by heating to the usual yellow red and quenched in water, being slowly immersed.

The saving on a die on which machine work has been done to any extent is quite a factor. Most diemakers have not heretofore considered it practical to weld these cavities and have made up others until a perfect one is obtained.

The success of the operation is ascribed, first, to the fact that the original metal is not brought to too high a heat; second, that the filling material is melted into the weld in one lump, and, third, that the heat from the added material is absorbed by the die itself. The welding rod contains much more carbon than needed, and if part of it is removed in the melting the remainder contains a requisite amount of carbon.

D.-B. COMPANY OPEN NEW PLANT

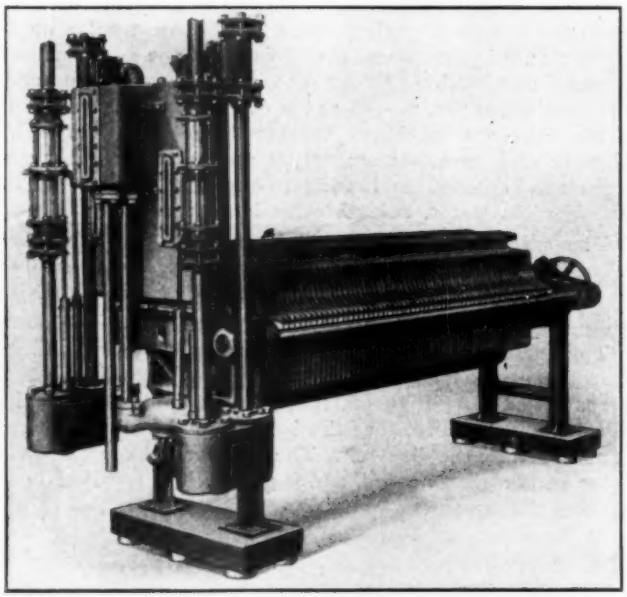
The Davis-Bournonville Company has increased the scope and efficiency of their Chicago branch by opening a new demonstrating plant and repair shop at 147 W. Austin avenue. The new plant will be in charge of Mr. Herman Ullmer, formerly assistant superintendent of the New Jersey plant. While not being fully equipped as yet, the plant is open for business and it is expected that all the machinery will be in place within a few days. The very latest standard equipment will be installed, including the Oxygraph, a special cutting machine, and the Radiograph, a special automatic barrel welding machine. This plant will be one of the best equipped shops of its kind in the West and will be prepared to take care of the lightest or heaviest casting. As a demonstrating plant it will also rank high, being a comprehensive and interesting example of the utility of oxy-acetylene apparatus.

Trade News

A NEW MACHINE FOR MAKING PURE OXYGEN AND HYDROGEN

The demand of oxygen and hydrogen for various industrial uses has grown very rapidly in the last five years. Certain lines of manufacture have been built up based on the oxygen process of welding, such as welded tanks, steel barrels, automobile parts, tubes, etc., while for repairing broken machinery, for reclaiming castings, for metal cutting of every nature, oxygen and hydrogen or oxygen and acetylene are used in steel mills, railroad shops, foundries and down to the smallest machine shop. Hydrogen likewise is in active demand; it is used more and more for cutting purposes and for light welding; it is also used for lead burning platinum smelting, in the manufacture of filaments for electric lamps; and to a very great extent in the new industry of hardening oils by the hydrogenation process. This rapid development in the uses of two gases was facilitated by the introduction into this country of oxygen and hydrogen generating apparatus several years ago. Large users of one or both of these gases were thus enabled to obtain their supply direct from their own generating plant at low cost, in a manner suitable to their individual requirements.

In the field of oxygen and hydrogen generating equipment the International Oxygen Company of New York from the beginning set a standard for high grade apparatus of workmanlike design and security of operation. The type of



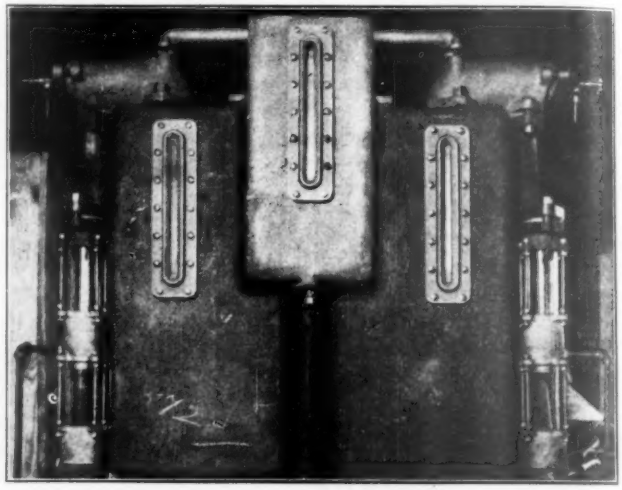
New Oxygen and Hydrogen Plant

machine manufactured by this company, known as the I. O. C. unit type, is recognized the most efficient and high class apparatus built and is in successful operation in numerous plants throughout the country. Today, the International Oxygen Company is bringing out a new style of oxygen and hydrogen generators under the name of the I. O. C. bipolar generators.

This type of generator resembles outwardly a filter press such as used in many chemical industries. Moritz, of Wasquehal, France, patented this type of apparatus in the United States and elsewhere, and I. H. Levin, of the International Oxygen Company, who studied under Moritz and Flamand, perfected this machine and incorporated in it many novel and ingenious features. The machine which is built at present by the International Oxygen Company is as different and as superior to the old Moritz machine as the I. O. C. unit type cell is superior to the method of making oxygen and hydrogen in college laboratories.

Briefly described, the I. O. C. bipolar generator consists of a series of metallic plates (electrodes) clamped up together in a heavy frame, electrically insulated from one another, and separated by diaphragms of porpus fabric. Each pair of these electrodes forms a closed cell divided by the diaphragm. These cells are filled with the electrolyte (caustic potash or soda), which acts as a conductor.

An electric current admitted at one end plate passes on through the plates and the solution to the other end plate.



Domes and Water Container with Gauges and Insulators

In its passage it decomposes the water in the solution into the two gases—oxygen and hydrogen—which are released on opposite sides of each plate and emerge upward into the gas off-takes. The mingling of the oxygen and hydrogen in each cell or compartment is prevented by the diaphragm which, while permitting the passage of the fluid, resists the passage of the gases, according to a well-known physical law.

As the gases are released and withdrawn, the solution is automatically replenished from a supply tank. The operation is continuous so long as current and electrolyte are supplies.

The Frame

In the smaller machines, the electrodes are carried on two steel rods supported on two heavy end pieces or pedestals of cast iron. In the larger generator the side rods are replaced by steel bars. The construction is one of extreme rigidity, absolutely proof against any distortion and consequent disarrangement of electrodes, with resultant leakage. It will be noted that there are only the two end supports—no middle support, as in some types—simplifying the problem of erection and alignment.

The electrodes are clamped together by a heavy screw working in the rear support. A feature of special note in the I. O. C. generator is that a ball thrust bearing is interposed between the end of the clamping screw and the rear end plate—a refinement not formed in other types, but contributing to the non-leaking qualities of the machine by doing away with the tendency of the electrodes to "ride up" from the side bars under screw pressure.

The Electrodes

These are of a special design covered by a patent of this company, the anode side being heavily nickeled, while the

cathode side is of commercially pure iron. This use of two metals has an important bearing upon the efficiency of the generator, referred to more fully later. The surfaces of the electrodes carry vertical corrugations which are interrupted by a large number of depressions to facilitate the flow of electrolyte into the cell and the release of the gases from it.

At top and bottom of each electrode are two openings communicating by a cored channel with opposite sides of the plate. Those at the bottom are for the water intake and those at the top are for the gas off-take. It will be seen that each half of each cell (separated by the diaphragm) has its own independent water intake and gas outlet, so that there can be no possibility of the two gases mingling through these channels. Any gas leakage which may occur between the electrodes escapes to the open air and not into the adjacent cell or into the gas off-takes.

The Diaphragms

These are of especially prepared asbestos fabric, of a thickness and texture carefully worked out by long experiment to give the best results. All around the edge of this fabric is moulded a packing rim of pure rubber which rests in a recessed groove on the face of the electrode.

Internal Insulation

Obviously, in a generator of this kind, an essential of power economy is that all the current supplied the machine shall pass through the electrolyte and none of it be by-passed through the metal of the machine or through the water inlets and gas outlets.

In the I. O. C. bipolar generator the electrodes are insulated from the side bars of the frames by porcelain insulators resting on a wooden bar in the large machine and on fibre in the small machine. They are insulated from one another, first, by the pure rubber packing rim surrounding the diaphragm; second, by nipples of pure rubber inserted in the water intake and gas off-take shoulders of the electrodes; these nipples, with everything clamped hoe, meeting one another and not only insulating the electrode shoulders but also providing an insulating tube in the interior of the water intakes and gas off-takes.

External Insulation

The gases riding from the electrodes and entering the gas off-takes carry with them a small percentage of the electrolyte which, if allowed to enter the external piping system, would "ground" the apparatus and permit the escape of current.

To guard against this contingency, there is provided in the gas off-take system insulating pipe sections, each consisting of two sections of heavy glass tube clamped between iron flanges and so devised as to intercept and drain off through an insulating connection the moisture entrained in the gases. The gases go through these insulators substantially dry and free from electrolyte.

Electrical Efficiency

The voltage supplied to any electrolytic gas generator is utilized in two ways, partly in decomposing the electrolyte and partly in overcoming the internal resistance of the generator. Electrical efficiency depends upon the minimizing of the decomposition voltage and the minimizing of the voltage overcome in ohmic resistance.

A number of the features of the I. O. C. Generator contribute toward high electrical efficiency. First of these is the use of the nickel anode and iron cathode (a patented combination), which has been found to materially facilitate the electrolysis or decomposition and to lower the over-voltage. Incidentally, these bimetallic electrodes prevent the formation of rust and oxides which would materially shorten the life of the apparatus.

A second feature in efficiency is the fact that the design of this generator is such as to retain within the apparatus most of the heat produced as a result of the ohmic resistance. This keeps the electrolyte and the electrodes at a comparatively high temperature, which adds to the efficiency of the electrolytic process. Furthermore, the electrolyte used—a solution of caustic potash—has been found by experiment to utilize the current to best advantage.

Water Feed

The generator is filled, on starting the apparatus, with the solution constituting the electrolyte. Obviously, as decomposition proceeds and gases are withdrawn, water must be supplied to the solution to maintain the right level and right density.

On the front of the generator are two tanks or domes with glass water level indicators which carry the solution. Pipes descend from these tanks to a water-feed manifold, which branches into two pipes connecting independently to the two water intakes to the cells and also into two risers leading to the two independent gas domes above. Into these domes the oxygen and hydrogen are separately discharged as generated, the gas off-takes opening through an inverted "U" below the fluid level.

Next to these domes is a feed-water tank discharging distilled water through a float-controlled valve, as needed, to the solution tank on the front of the generator.

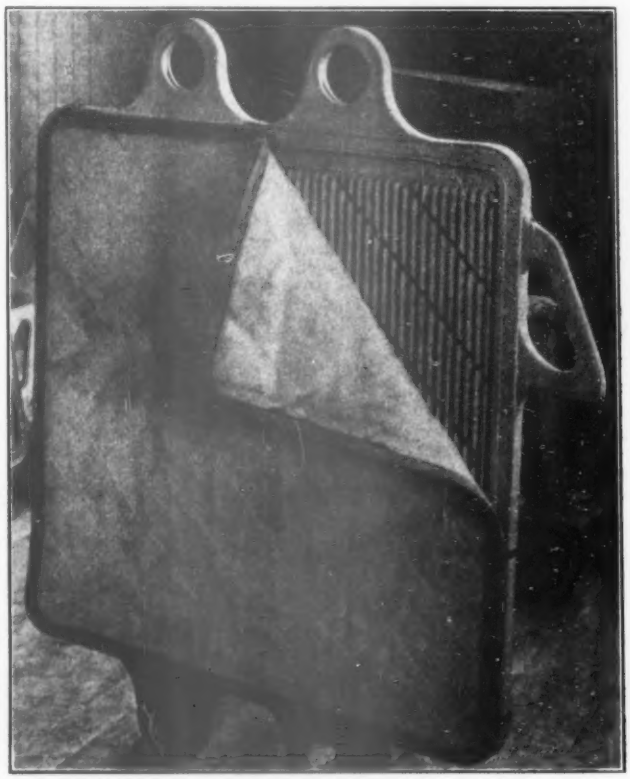


Plate with Diaphragm

Arrangements are such that the proper fluid level is automatically maintained throughout the system. The two independent water intakes to either side of each electrode absolutely prevent any mingling of oxygen and hydrogen through the water supply.

This water-feed device creates an absolute balance of pressures throughout the generator, the vital importance of which will now be noted. Furthermore, it makes the water feed absolutely proportioned to and under the control of the rate of gas generation.

Control of Water Pressure

A primary essential in a generator of this type is to minimize circulation through the diaphragms, the function of these diaphragms being only to segregate the two gases as released, at the same time permitting the passage of the electrolyte through their pores.

The two independent water supplies—one to either side of each diaphragm, but both under exactly the same pressure, due to the hydrostatic head in the solution tank—obviously put the diaphragms under balanced fluid pressure, and eliminate circulation through them, due to unequal pressure on their two sides.

This has two vital results. First, it removes any tendency to cause a mingling of gases through the diaphragm. Second, it relieves the diaphragm material from all mechanical stress and obviates any destructive erosive action which might be caused by solid particles in the electrolyte being forced through the fabric. This absolute balance and control of water pressure then affects both the purity of the gases and the life of the apparatus.

Control of Gas Pressures

The two gas off-takes discharge into the two independent gas domes already referred to, the gas emerging below the fluid surface through an inverted "U." It is apparent, then, that the pressure on both gases, clear back to the individual cells, is the same—being that determined by the hydrostatic head in the domes through the two independent risers from the water-feed manifold.

This balanced pressure in both gas off-takes forbids any mixture of the gases and contributes to the balancing of pressures on the diaphragms. It will be noted that gas and water pressures are predetermined and constant.

Purgers

The gases escaping from the gas off-takes rise through the fluid in the gas domes and pass out through discharge pipes at the top of the domes, thence downward to purgers in either side. These purgers are closed boxes of cast iron filled with water to a certain level. The gases, except below the surface of this water, pass upward through it and emerge thence through the supply lines to the gasholders.

The function of these purgers is threefold: first, to catch any entrained fluid in the gas; second, to cool the gas; third, to act as a water-check valve, protecting the pressure system of the generator from any undue pressure of the gasholders.

Safety and Indicating Devices

A signal whistle is provided which gives notice when the level of the solution in the generator falls below the described limit. Glass sight feed indicators on the solution tank and gas domes show the fluid levels and reveal the generation of the gases. Gauge glasses connecting with the electrodes at intervals along the generator show the fluid levels in the body of the apparatus.

Drain Valves

To permit the emptying of solution from the generator when required, drain valves are provided. These are of the lever-operated gate type, designed to obviate any leakage or wear due to the presence of solid matter in the fluid.

As will be seen from the above description, the I. O. C. Bipolar Generator is a complete machine, perfectly adapted to the ends sought. An ideal type of electrolytic generator must combine (a) electrical efficiency, (b) continuity of operation, (c) purity of the gases produced, (d) highest degree of safety, (e) correct design, insuring long life and little, if any, maintenance cost. The I. O. C. Bipolar embodies these requirements completely. The machine is designed for steady and continuous work and for great durability.

The quality of the materials used in the machine is perfectly suited to all the physical and chemical strains for which the machine is designed, even under severe conditions of overload. The diaphragms separating the gases are made of the same high grade of special material as those that have been giving satisfactory results in the unit type generator of the I. O. C. system. The surfaces of the electrodes are specially treated with the result that efficiency of the apparatus is extremely high. In addition, this patented treatment of the electrodes prevents the formation of rust and oxides and thus appreciably lengthens the life of the apparatus. The rubber used in the generator is the only material that is subject to deterioration and may require replacing.

Attendance

The I. O. C. Bipolar Generator has been developed to a point where it is as completely automatic as a high-quality device can be made. Practically the only attention required in operation is a maintenance of the water supply.

It is not to be inferred from this that the company recommends that these machines be started and then left absolutely to themselves. No mechanism is perfect—and the best apparatus made deserves a fair measure of consideration and attention. But the I. O. C. Bipolar Generator certainly calls for the minimum of attendance—at the most, only a small part of one man's time. And this feature contributes largely to the low cost of gas production to be realized by this apparatus.

WELDED JOINTS WITH 482 PER CENT GREATER EFFICIENCY THAN RIVETED JOINTS

A striking example of the increased efficiency and generally decreased cost of manufacture by welding sheet steel articles compared with drilling and riveting is shown on the steel trucks made by the Standard Improved Truck Co. of Chicago.

This truck was previously made by drilling and riveting all the joints.

Welding by the Oxy-acetylene Process was proposed and a test truck made by this method. The results were so conclusively in favor of this construction (see copy of Robt. W. Hunt & Co.'s report below) that it was immediately adopted and the riveting process abandoned.

This is a Welded Product. Was previously made by Drilling and Riveting

Welding not only produces a one-piece truck with an efficiency at the welds 482% greater than a riveted joint, but has increased the output per man about 20% with a saving of over 30% of the previous cost of manufacture per truck.

A copy of the Robt. W. Hunt & Co.'s report of tests made on the welded and riveted joint follows:

(Continued on page 32)

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(Continued from page 30)

Robert W. Hunt and Co., Engineers.

Bureau of Inspection, Tests and Construction.

Chicago. May 6, 1912.

The following is a report of our special tests on riveted and welded connections of the tubular steel rack of your steel body truck. Three connections were submitted, and were subjected to tests under identical conditions. The specimens were set in the testing machine as is indicated in the sketch following. Steel plugs were inserted in the pipe at the location "E", "F", and "G" to prevent the collapse of the tubes at these locations.

Test Connection "A"

Method of connection—welded by oxy-acetylene torch.

	Stringer Tube	Cross Tube
Outside diameter, in	1.67 inches	1.31 inches
Inside diameter	1.41 inches	1.05 inches
Thickness of pipe	.13 inches	.13 inches

Under a load of 17090 the cross tube on which the tension or pull was applied commenced to scale, indicating that the elastic limit of the steel in tension had been reached.

Under a maximum load of 25,460 lbs. the cross tube broke from the stringer tube at the weld. At 24,540 lbs. there was noticed considerable reduction in the cross section of stringer pipe at point of connection, but no sign of rupture at weld.

Test Connection "B"

Method of connection—riveted, two ¼-in. diameter rivets in double shear, one each in stringer and cross tube through plug and bushing inserted in cross tube.

	Stringer Tube	Cross Tube
Outside diameter, in	1.67 inches	1.31 inches
Inside diameter	1.41 inches	1.05 inches
Thickness of pipe	.13 inches	.13 inches

Under a load of 2,920 lbs., a $\frac{1}{16}$-in. slippage of the connection was observed, due to the bending of the rivets and loosening of the connection. Under a maximum load of 4,740 lbs. the rivet in the stringer tube sheared off.

Test Connection "C"

Method of connection—riveted connection with ¼-in. rivet in double shear in cross tube and ¼-in. riveted reduction of inserted plug through stringed tube—head of the same in tension.

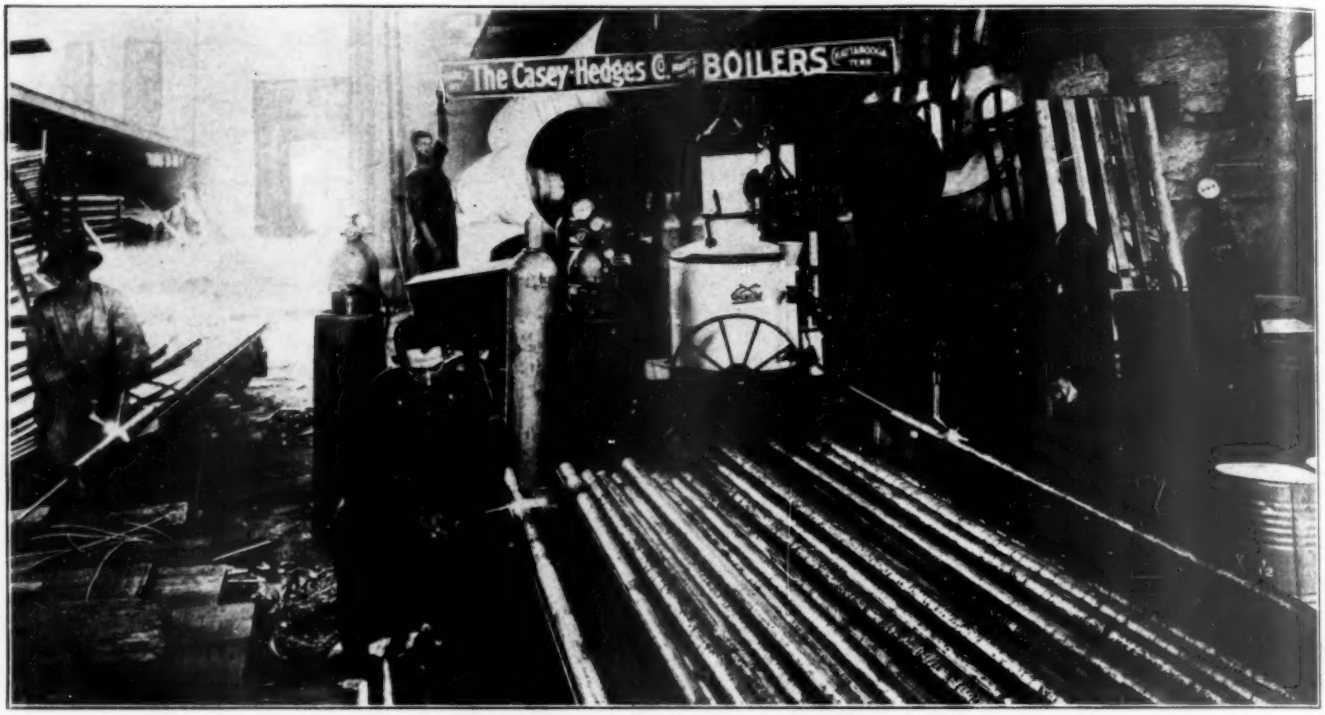
	Stringer Tube	Cross Tube
Outside diameter, in	1.67 inches	1.31 inches
Inside diameter	1.41 inches	1.05 inches
Thickness of pipe	.13 inches	.13 inches

Under a load of 3,060 lbs. a $\frac{1}{16}$-in. slippage of the connection was observed as a result of the bending of the rivet in the cross tube and a general loosening of the connection. At 4,010 lbs. the separation at point of connection was ¼-in. under a maximum load of 5,800 lbs. the rivet in the cross tube sheared off and the rivet connection in the stringer tube pulled partially through the said stringer tube.

Respectfully submitting the above, we are

Yours very truly,

Robert W. Hunt & Co.



Mistakes will happen, but in this case Oxy-Acetylene Operators corrected a serious error without much loss.

WELDING SHORT BOILER TUBES SAVES HEAVY CONTRACT PENALTY

It is in emergency cases, where money and time factors are at stake, that the oxy-acetylene blowpipe demonstrates its value as a utility tool. A case of this sort is pictured in the accompanying view, showing operators at work welding twelve hundred 2¼-in. boiler tubes, which, through an error, had been cut 2 feet too short.

This work was done at the plant of the Casey-Hedges Company, Chattanooga, Tenn., for the T. C. I. & R. R. Company, and was a rush contract job let on a heavy bonus and penalty basis.

Following the discovery of the error it was found impossible to obtain sufficient tubing of the proper length to fill the contract under three weeks' time. The boiler tubes were intended to be used in the construction of condensers for a benzol plant, and without being installed in reasonable time meant a large loss to the contractors.

The T. C. I. & R. R. Company is an extensive user of the oxy-acetylene process, and by putting three oxy-acetylene operators at work was able to deliver the welded tubes in plenty of time under the contract.

It was estimated that previous to the actual welding that

the cost would average about twenty cents per tube, excluding traveling and other expenses necessitated by the limited time in which to do the work. The final figures showed that the total expenses would come to about this amount. Following are the details of the welding work:

Oxygen, 1,200 feet, 1¾c	$ 21.00
Acetylene, 750 feet, 2c	15.00
Carbide, 150 lbs. 4c	6.00
Labor, 126 hrs., and overtime	64.50
Labor, 60 hrs., 32c	19.20
Filler, 100 lbs., 8c	8.00
Total	$133.70

It will be noted that compressed acetylene was used. This was necessary because a generator ordered did not arrive in Chattanooga until the work was partially completed, compressed gas being used in the interim. The above figures would signify that under ordinary conditions this sized boiler tube can be welded for ten cents each, or less.

The tubes were welded on cold mandrels turned down to ½-in. under size and hammered while hot, thus increasing the tensile strength, eliminating the possibility of leaks developing, and permitting slight reinforcement without increasing the size of pipe so as to interfere in passing through reamed holes in tube sheets. There was only 1/32-in. play and every pipe had to pass entirely through the tube sheets, already built into the condensers.

It is stated that the cost of welding the tubes by the roller process would be about 30 cents each, showing a very substantial saving effected by oxy-acetylene. The welded tubes were later tested under high pressure and showed no signs of weakness. The contractors were highly pleased with the work, through the large savings made and efficiency of the welded joints.

PROBLEMS OF THE JOB SHOP

Many of the queries reaching the office of The Welding Engineer have to do with the most difficult of oxy-acetylene welding, that of tool steel and high carbon steels.

The reason for the general difficulty in welding high carbon steels is two fold, ignorance of the composition of the steel and a general lack of practice.

There is nothing that will compensate for lack of general knowledge of a subject or lack of skill through inexperience excepting information on that subject and practise in performing the work.

It will, therefore, be best to divide the information which can be obtained into two classes, one for the operator who already has gained skill in the welding of low carbon steels, and the other for basic instruction in welding steel.

The low carbon steels are known as cold drawn, open hearth and Bessemer. They are very few compared with the different high carbon steels, in which nickel, vanadium, manganese, tungsten, ferro-tungsten, aluminum and many other metals enter in varying quantities.

There would be no doubt of the locality of his trouble if the average welder could have put before him the varied and intricate analyses of many of the high carbon steels of the day. But his greatest error of all is a very simple one.

The welder, having a heat equal to almost 6,300 degrees Fahrenheit, turns it on steel having a melting point of 1,800 to 2,500 degrees Fahrenheit and leaves it there on the one spot too long or goes over the work too many times.

If the furnace tender in the steel mills where the steel was made allowed the steel to get to the temperature that many an inxperienced welder puts on a crank shaft, his huge vat of steel would be burned and valueless, just as are the oxy-acetylene welder's crank shafts or dies.

From long observation of the most successful welders of high carbon steel, it is apparent that these operators progress more evenly along the weld, do not use so much heat from the torch and thereby avoid burning the metal.

Reports from successful operators show that the workman who is expert on sheet welding on low carbon steel is always better on the high carbon steels for the foregoing reasons. The workman with confidence progresses more evenly, the heat is better distributed throughout the weld and no one spot reaches the danger mark of heat. The experienced eye can always tell when the steel is being burned or robbed of its carbon and the bad "spots" in a steel weld always mark the points where the welder has stopped or gone back to fill in. The experienced operator fills as he goes and neither stops nor goes back over the weld.

But even a lack of skill, experience or the trained eye of an amateur account for the failure of some steels to "work right." There are many other contributing causes, such as an excess of oxygen in the flame caused by a poor or clogged mixer in the torch, use of the wrong filler rod, or lack of after treatment or annealing, which is necessary with some steels.

There are at least seven different steels used in welding steel and although many welders profess to be able to use but one grade on all steel or iron jobs, actual practise in manufacturing plants decides the best grade for the different kinds of steels.

Generally speaking, the old adage found in every text book holds good, and that is "Use a welding rod of the same composition as the piece to be welded." This is true except that a welding rod, to be a good one, should melt at a lower temperature than the work and if possible it should contain a flux to enable it to combine more freely instead of trusting to the operator to put the flux on the right spot.

It should melt at a lower temperature because the operator should not have to remove the torch from the weld to melt the filler rod and it should contain a flux if possible to enable it to combine more freely with the molten material instead of trusting to the operator to apply the flux to the right spot. The flux in the rod, as, for instance, silicon in cast iron and phosphorus in bronze, are examples of this.

Since, however, steel needs no flux in welding, the melting qualities only need be cosidered. No matter whether using Norway iron, pure iron, Bessemer or crucible steel welding rods the size of the welding rods should never be too large, as then it would take more than the excess heat from the torch to melt the rod, delaying the operator.

Careful study of the methods of a steel welder will disclose the fact than he automatically runs more welding rod into the weld as the heat exceeds a certain point. The fresh added metal absorbs the heat and prevents burning. The relation betwen the length of time the torch is held on the weld and the rate at which the welding rod is fed becomes a nicely balanced proportion and the result is a strong, smooth weld. The small circles in which the experienced welder keeps moving his torch also means a more even distribution of the heat and less burning. The selection of a tip which will allow an even rate of progress along the weld is also a matter of experience and inasmuch as almost all torches vary in size of tips, this must be learned first from the makers or through experience.

In the matter of preheating steel parts, many welders do not believe in preheating at all for solid work, such as rounds and blocks, while others get the steel red or white before welding. Low carbon steels can be successfully welded after being preheated to a red or white, but the high carbon steels should not be brought to or over a straw color.

It is the purpose of this article to point out the usual pitfalls in welding all grades of steel. It is best to understand and be able to do the least difficult before attempting the more intricate problems.

It is usually very hard for the operator in even a large job shop to get enough work in any one kind of steel, especially high carbon steels, to be able to tell how and why he uses certain methods in welding any particular metal. It is therefore from the manufacturers who keep their oper-

ators busy day in and day out on the same metals that data is best gathered.

Note: In future articles the author will take up the various steels and tell of the experience of manufacturers of these steels.

LYON & HEALY WELDING

When the European war began there were several firms in this country who at once set out to do for themselves what had formerly been done by foreign workmen, in foreign shops, and in foreign ways.

Among these concerns was the well known Chicago musical instrument house of Lyon & Healy. They together with others in the same line had been buying imported piano stools and instrument parts for many years and when the war shut off these supplies they were left with a rapidly diminishing stock and the prospect of having to turn out in small quantities the parts which formerly they were able to order from the New York or Chicago representatives of the foreign firms.

The shape of many of these tools and parts suggested at once to these firms the practicability of electric welding. Some of the problems were to save the cost of an entire article made of carbon or high speed steel by making the wearing or bearing parts of the harder and more costly steels and welding on other parts of cold rolled or Bessemer steel.

Also by using an electric welder, two parts of unequal size or diameter could be welded together, thus saving the material and labor involved in cutting the article out of solid stock.

After some preliminary training a workman from the shop was able to make the welds and after the first few mistakes of inexperience was turning out work equal to the best imported goods.

It was on the cost sheets for the different articles manufactured in this way that the greatest surprise of all was met. It was at once apparent that on several articles on which competition with the European manufacturers was thought impossible on account of their low selling price all cost prices had been shattered.

For instance, a piano tool which formerly cost, imported, approximately thirty cents, was made up for fourteen cents in lots of 500 and on the second lot of 500 the cost price was still further lowered.

In commenting on this remarkable showing an official of the company remarked:

"Even if the war ends tomorrow we will keep right on making them ourselves."

And in this decision many manufacturers who command the services of a live and well read engineering and purchasing department are joining daily.

TRADE NEWS

The K.G. Welding and Cutting Co., 556 West 34th St., New York City, have recently issued an attractive wall calendar.

"Always in line with the progressive business organizations of the country, the International Oxygen Co., announces that after Jan. 1st, 1916, they will inaugurate the 8-hour day at their works, Newark, N. J."

The Goldscmidt Thermit Company, 90 West street, New York, has recently issued three attractive bulletins relative to the Thermit process of welding. One is a folder, treating in a somewhat general way of the subject of locomotive repairs. The other two are much more elaborate and are entitled, respectively "Thermit Locomotive Repairs" and "Thermit Mill and Foundry Practice." These books contain instructions for the use of Thermit and are illustrated with drawings and other views showing the necessary steps to be taken. There are also a number of views showing the results which may be obtained.

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FORGING
OF
IRON AND STEEL

BY

WILLIAM ALLYN RICHARDS, B. S. in M. E.

Principal of the Grant Vocational High School, Cedar Rapids, Iowa. Fomerly Supervisor, Manual Training High School, Rockford, Ill., and Instructor in Forge, Foundry and Machine Practice in the University High School and University of Chicago, Chicago, Ill.

CONTENTS.

Chapter I. Introduction. II. Historic Use of Iron and Steel. III. Iron and Steel. IV. Equipment. V. Fuel and Fires. VI. Drawing Down and Upsetting. VII. Bending and Twisting. VIII. Splitting, Punching and Riveting IX. The Uses of Blacksmith's Tool. X. Welding. XI. Electric, Autogenous and Thermit Welding. XII. Brazing. XIII. Tool Steel. XIV. High Speed Tool Steel. XV. Art Iron Work. XVI. Steam and Power Hammers. XVII. Calculations. Appendix.

A simple treatment of the subject for the use of high-school classes, yet thorough and systematic enough to be a useful manual for the practicing smith. The work aims to elucidate the underlying principles of the subject, and in a series of review questions that close each chapter brings out the important phases of the various processes discussed. In an appendix the author presents a set of exercises, each of which exemplifies some principle of forgework, thus giving the teacher an opportunity to map out a course in the subject best suited to the equipment of the school.

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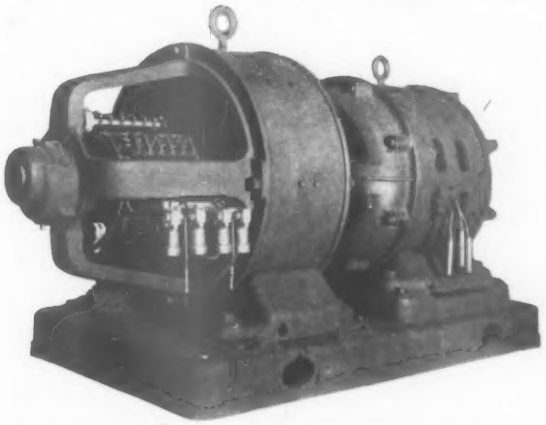
220 So. State Street CHICAGO, ILL.

Electric Arc Welding on Boilers



WESTINGHOUSE ARC-WELDING MOTOR-GENERATOR SET. CAN BE SUPPLIED FOR OPERATION ON ANY COMMERCIAL POWER CIRCUIT

One Railroad Man Writes to Another

On Westinghouse Electric Arc Welding Equipment

"I am very pleased to state that this equipment has given entire satisfaction and absolutely no trouble and that we are performing all classes of welding work, including that directly overhead and flue welding. In connection with the latter class of work we are meeting with particularly good success . . . . We have four operators regularly at work each day and there have been no cases where the work of one operator in any way interfered with the others." (Name of road on request.)

This extract from a letter written by a user of

Westinghouse Electric Arc Welding Equipment

to a friend considering the installation of a similar equipment (whose road has since purchased two outfits) states very positively the successful operation to be expected with our apparatus. And this is not an unusual case. All our users are equally enthusiastic.

You can get as good results as this road has with a Westinghouse arc welding equipment in your shop. Twenty-one large railroad systems have standardized on this equipment. Let us tell you why.

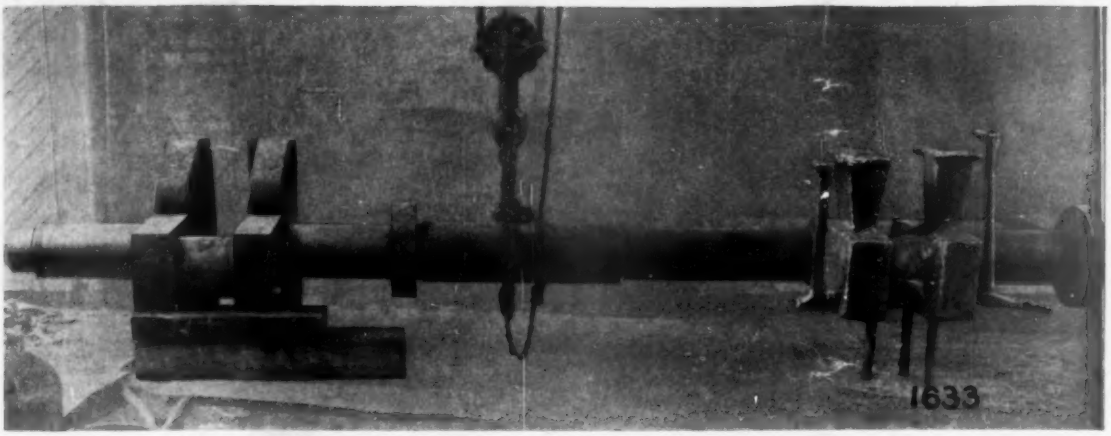
Send for our booklet "Electric Arc Welding Processes"

Westinghouse Electric & Mfg. Co.

Sales Offices in All Large American Cities

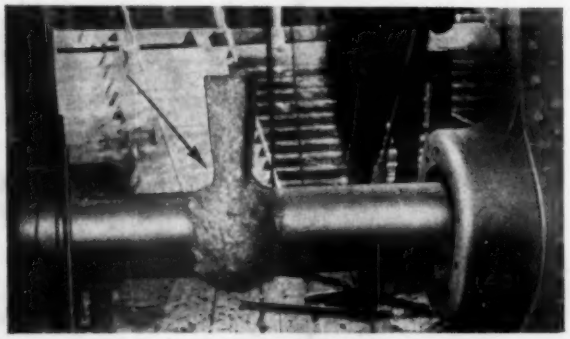
East Pittsburgh, Pennsylvania

Say Welding—Think Westinghouse



Thermit Welds on 8½-in. Crankshaft. Two new webs and a crank pin were welded in one operation

Large Dredge Dipper welded with Thermit before trimming



11-in. Tail Shaft welded for steamship without removing it from vessel

The Thermit Welding Process Is the ONLY One That Will Give You a Permanent Repair on Wrought Iron and Steel Sections

WHAT THERMIT IS

Thermit is a mixture of granulated aluminum and iron oxide which, when ignited, reacts, producing superheated liquid steel at a temperature of 5400 degrees F.

HOW WELDS ARE MADE

A broken section is lined up and a mold built around the fracture. The fracture is brought to a red heat by a special preheater and the Thermit mixture is placed in a special crucible so that when the Thermit reaction is over, the liquid steel can be poured from the bottom of the crucible into the mold, and being at such a high temperature, is sufficiently hot to melt the sections with which it comes in contact and amalgamate with them to form a solid mass when cool.

Broken crank shafts, mine hoist shafts, gear wheels, fly wheels, dredge sections, engine frames, rock crusher shafts, and many other heavy sections, can be restored to service in one or two days at slight expense and often effect a saving of thousands of dollars in time and repair costs.

When you realize the advantages to be derived from use of Thermit for repairs you will install the process at once.

Write for Bulletin No. 1779

GOLDSCHMIDT THERMIT CO.

WILLIAM C. CUNTZ, General Manager

90 WEST STREET, NEW YORK

329-333 Folsom St., San Francisco 7300 So. Chicago Ave., Chicago
103 Richmond St., W., Toronto, Ont.

Crankshaft machined and ready for service. The arrow points to location of Thermit welds